

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION		see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No.	International filing date (day/month/year)	(Earliest) Priority Date (day/month/year)	
PCT/GB 99/00573	05/03/1999	07/03/1998	
Applicant THE ENGINEERING BUSINESS LIMITED et al.			

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.
☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :
- ☐ contained in the international application in written form.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority in written form.
 - ☐ furnished subsequently to this Authority in computer readable form.
 - ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
 - ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

- ☒ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.

1
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

National Application No
PCT/GB 99/00573

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F03B17/06 F03D5/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 F03B F03D B63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 34 25 426 A (BARTRAM JUN JENS) 16 January 1986 see abstract see claim 1; figures	1
A	WO 87 04401 A (HELMSVILLE PTY LTD) 30 July 1987 see abstract see page 4, line 12 - line 30; figures 3,4	1
A	WO 80 01674 A (HARTMANN E) 21 August 1980 see page 6, paragraph 3 - page 8, paragraph 1; figures 4,5	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

18 June 1999

Date of mailing of the international search report

25/06/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Criado Jimenez, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/00573

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 3425426	A	16-01-1986	NONE	
WO 8704401	A	30-07-1987	AU 6894487 A	14-08-1987
WO 8001674	A	21-08-1980	EP 0023501 A	11-02-1981

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No.	International filing date (day/month/year)	(Earliest) Priority Date (day/month/year)
PCT/GB 99/ 00573	05/03/1999	07/03/1998
Applicant		
THE ENGINEERING BUSINESS LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

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☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/00573

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 F03B17/06 F03D5/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 F03B F03D B63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 34 25 426 A (BARTRAM JUN JENS) 16 January 1986 see abstract see claim 1; figures ----	1
A	WO 87 04401 A (HELMSVILLE PTY LTD) 30 July 1987 see abstract see page 4, line 12 - line 30; figures 3,4 ----	1
A	WO 80 01674 A (HARTMANN E) 21 August 1980 see page 6, paragraph 3 - page 8, paragraph 1; figures 4,5 -----	1

☐ Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

18 June 1999

Date of mailing of the international search report

25/06/1999

Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Criado Jimenez, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/00573

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 3425426	A	16-01-1986	NONE		
WO 8704401	A	30-07-1987	AU	6894487 A	14-08-1987
WO 8001674	A	21-08-1980	EP	0023501 A	11-02-1981

PATENT COOPERATION TREATY

PCT

REC'D 13 MAR 2000

WIPO

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference xxx	FOR FURTHER ACTION		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB99/00573	International filing date (day/month/year) 05/03/1999	Priority date (day/month/year) 07/03/1998	
International Patent Classification (IPC) or national classification and IPC F03B17/06			
Applicant THE ENGINEERING BUSINESS LIMITED et al.			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 06/10/1999	Date of completion of this report 09.03.00
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fistas, N Telephone No. +49 89 2399 2936



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB99/00573

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-22 as originally filed

Claims, No.:

1-47 with telefax of 22/02/2000

Drawings, sheets:

1/13-13/13 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB99/00573

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-44
	No: Claims
Inventive step (IS)	Yes: Claims 1-44
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-44
	No: Claims

2. Citations and explanations

see separate sheet

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB99/00573

1. In new claim 1 the expression "periodically" has been added to specify the reversal in the direction of thrust. However, no basis in the originally-filed application can be found for the above-mentioned expression.

The wording of the new method claim 42 differs from the wording of the method claim 43 as originally filed. With respect to the amendments made in new claim 42, no basis can be recognised for the deletion of the features that "repeatedly reversing the direction of thrust generated by at least one submerged control member protruding from a side of the body".

Section V

2. The invention relates to a prime mover, an apparatus and a method for extracting power from a current of water.

The nearest prior art is e.g. GB-A-1 604 372 identified in the description.

The object of the invention is to provide a prime mover which is ideally suited for extracting energy from flowing water.

Since means for performing actively the reversal in the direction of the thrust even though the direction of the flow of water remains unchanged for such a prime mover, apparatus and method are not contained in any of the prior documents, the subject-matter defined in claim 1, 23 and 42 is new. Furthermore, said subject-matter is considered to be inventive because none of the cited documents or combination thereof contains any hint that could lead in an obvious way to the combination of features described in the independent claims 1, 23 and 42.

The subject-matter of the dependent claims 2-22, 24-41, 43 and 44 are considered to be new and inventive, since they concern particular embodiments of the prime mover, the apparatus and the method defined in claim 1, 23 and 42 respectively.

Section VII

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB99/00573

3. Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (document GB-A-1 604 372) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).
4. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
5. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents WO-A-87 04401 (D1) and WO-A-80 01674 (D2) are not mentioned in the description, nor are these documents identified therein.
6. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

Section VIII

7. Claims 45, 46 and 47 contain references to the description and/or the drawings. According to Rule 6.2 (a) PCT, claims should not contain such references except where absolutely necessary, which is not the case here. Therefore, these claims should have been deleted.
8. The vague and imprecise statement in the description on page 2, lines 16-20 implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

CLAIMS

1. A prime mover for extracting power from a current of water comprising:

5 a body;

a control member protruding from a side of the body and adapted for submersion in the current of water to generate thrust;

10 means for periodically reversing the direction of the said thrust, causing the body to oscillate; and

means for extracting power from the oscillatory movement of the body.

15 2. A prime mover according to claim 1 in which at least one control member protrudes from each side of the body.

20 3. A prime mover according to claim 1 or 2 in which the shape of the body is such that water is caused to travel faster over a portion of the surface of the body and in which one or more protruding control members are positioned at that portion of the surface of the body.

25 4. A prime mover according to claim 3 in which the body comprises curved sides which orientate the body with respect to the current of water so that the control member or members are substantially perpendicular to the direction of the current.

30 5. A prime mover according to any proceeding claim in which the shape of the sides is symmetrical.

6. A prime mover according to claim 3, 4 or 5 in which the sides of the body are convex.

7. A prime mover according to any preceding claim in which at least one second protruding control member is provided fixed with respect to the body and arranged so that when the direction of thrust of a first reversible protruding control member is reversed, the angle of the second fixed control member with respect to the current of water is altered so that the action of the water on that second fixed member causes the body to oscillate.
8. A prime mover according to claim 7 in which the fixed second control member is positioned at a point on the body at which the velocity of the water current flowing past the body is at or near a maximum and the first reversible control member is spaced laterally from it in the direction of the water current.
9. A prime mover according to any preceding claim in which one, or more control members comprise hydroplanes whereby the direction of thrust is reversed by the angle of inclination of at least one hydroplane.
10. A prime mover according to any preceding claim in which one or more reversible control members is pivotable in its entirety.
11. A prime mover according to any preceding claim in which one or more reversible control member is pivotable about an edge of that member protruding from the body.
12. A prime mover according to any preceding claim in which one or more reversible control members is pivotable about a centrally located axis protruding from the body

and passing through the member.

13. A prime mover according to any preceding claim in which one or more of the reversible control members are
5 formed by pivotable flaps mounted to a control member or other mounting means fixed with respect to the body.

14. A prime mover according to any preceding claim in which one or more reversible control members have an
10 aerofoil shape.

15. A prime mover according to any preceding claim in which one or more control members comprise a rotatable cylindrical structure, the direction of rotation of which
15 can be reversed so as to cause a change in the direction of thrust generated.

16. A prime mover according to any preceding claim in which the distribution of control members on opposing
20 sides of the body is symmetrical.

17. A prime mover according to any preceding claim in which the body is elongate and tends to orientate itself so that it is elongate in the direction of the current.
25

18. A prime mover according to any preceding claim in which the body oscillates in a vertical direction.

19. A prime mover according to any preceding claim in which more than one control member is provided on
30 opposing sides of the body.

20. A prime mover according to claim 19 in which the

control members are spaced along the body in a direction substantially perpendicular to the direction of the current when the body is orientated so that its control members protrude from the body in a direction
5 substantially perpendicular to the direction of the current.

21. A prime mover according to claim 20 in which the body is arranged to oscillate vertically and two or more
10 control members are provided on opposing sides of the body in a substantially vertical line.

22. A prime mover according to claim 20 or 21 in which three or more control members are provided on each side
15 and the separation of the control members is substantially equal.

23. Apparatus for extracting power from moving water comprising a prime mover according to any preceding
20 claim.

24. Apparatus according to claim 23 in which the prime mover is connected to mooring means secured or securable under water.

25. Apparatus according to claim 23 or 24 in which the prime mover is connected to mooring cable.

26. Apparatus according to any of claims 23 to 25 in
30 which the prime mover is axially slidably mounted or mountable to a column secured or securable under water in an upright position.

27. Apparatus according to claim 26 in which the prime mover comprises a downwardly extending tube which surrounds the column.

5 28. Apparatus according to any of claims 23 to 27 in which the prime mover is submerged when generating power.

29. Apparatus according to any of claims 23 to 28 in which power conversion means are provided comprising one
10 or more hydraulic pumps, a crank arrangement, or means for generating electricity, such as an electric coil and magnet.

30. Apparatus according to any of claims 23 to 28 in
15 which power conversion means are provided comprising a fluid pump for pumping fluid to a higher level to store potential energy.

31. Apparatus according to any claims 23 to 30 moored to
20 or mounted on a structure such as a column on which apparatus for extracting power from wind is mounted.

32. Apparatus according to any of claims 23 to 31 in
25 which the prime mover is buoyant.

33. Apparatus according to any of claims 23 to 32 in which the prime mover comprises an open bottomed tank which when it oscillates alternately compresses and decompresses a fluid inside it between a closed top of
30 the tank and the water surface.

34. Apparatus according to claim 33 in which at least one duct in the top of the tank permits the fluid

alternately to flow out of and into the tank.

35. Apparatus according to claim 34 in which the fluid flowing through one or more ducts drives a turbine.

5

36. Apparatus according to claim 35, in which two or more ducts are provided and the number of ducts selected can be varied and/or in which the size of one or more ducts can be varied.

10

37. Apparatus according to claim 35 or 36 in which a turbine is housed in a duct.

15

38. Apparatus according to any of claims 36 to 37 in which the turbine rotates in the same direction irrespective of the flow of fluid out of or into the tank.

20

39. Apparatus according to any of claims 35 to 37 in which valve means are provided so that fluid passes through the turbine in the same direction irrespective of the flow of fluid out of or into the tank.

25

40. Apparatus according to any of claims 34 to 39 in which the turbine is directly drivably connected to an electrical generator.

30

41. Apparatus according to any of claims 33 to 39 in which the fluid is air.

42. A method for extracting power from a current of water using a prime mover as claimed in claim 1, comprising periodically reversing the direction of thrust

generated by the said control member, using the means provided for that purpose.

43. A method according to claim 42, in which the control
5 member comprises a hydroplane whose angle of inclination can be reversed.

44. A method according to claim 42, in which the control
10 member comprises a rotating cylindrical member whose direction of rotation can be reversed.

45. A prime mover substantially as described herein with
reference to and/or as illustrated in the accompanying
15 figures.

46. Apparatus for extracting power from moving water
substantially as described herein with reference to
and/or as illustrated in the accompanying figures.

20 47. A method for extracting power from moving water
substantially as described herein with reference to
and/or as illustrated in the accompanying figures.

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

INFORMATION CONCERNING ELECTED
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

To:

ELLIS, Kate
Dibb Lupton Alsop
Fountain Precinct
Balm Green
Sheffield S1 1RZ
ROYAUME-UNI

ENTERED BY

08 NOV 1999

CHECKED BY

Date of mailing (day/month/year) 03 November 1999 (03.11.99)		
Applicant's or agent's file reference 71175.00		
IMPORTANT INFORMATION		
International application No. PCT/GB99/00573	International filing date (day/month/year) 05 March 1999 (05.03.99)	Priority date (day/month/year) 07 March 1998 (07.03.98)
Applicant THE ENGINEERING BUSINESS LIMITED et al		

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

AP : GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE

National : AU, BG, BR, CA, CN, CZ, DE, IL, JP, KP, KR, MN, NO, NZ, PL, RO, RU, SE, SK, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

EA : AM, AZ, BY, KG, KZ, MD, RU, TJ, TM

OA : BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG

National : AL, AM, AT, AZ, BA, BB, BY, CH, CU, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IN, IS, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MW, MX, PT, SD, SG, SI, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW

3. The applicant is reminded that he must enter the "national phase" before the expiration of 30 months from the priority date before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed until 31 months from the priority date for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35	Authorized officer: Marc Salzman Telephone No. (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:

ELLIS, Kate
Dibb Lupton Alsop
Fountain Precinct
Balm Green
Sheffield S1 1RZ
ROYAUME-UNI

Date of mailing (day/month/year)

10 September 1999 (10.09.99)

Applicant's or agent's file reference

71175.000

IMPORTANT NOTICE

International application No.

PCT/GB99/00573

International filing date (day/month/year)

05 March 1999 (05.03.99)

Priority date (day/month/year)

07 March 1998 (07.03.98)

Applicant

THE ENGINEERING BUSINESS LIMITED et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
AU,CN,EP,IL,JP,KP,KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CU,CZ,DE,DK,EA,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,
ID,IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MN,MW,MX,NO,NZ,OA,PL,PT,RO,RU,SD,
SE,SG,SI,SK,SL,TJ,TM,TR,TT,UA,UG,UZ,VN,YU,ZW

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
10 September 1999 (10.09.99) under No. WO 99/45268

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Authorized officer

J. Zahra

Facsimile No. (41-22) 740.14.35

Telephone No. (41-22) 338.83.38

DIBB LUPTON ALSOP

12 MAY 1999

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

To:

ELLIS, Kate
Dibb Lupton Alsop
Fountain Precinct
Balm Green
Sheffield S1 1RZ
ROYAUME-UNI

**NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT**

(PCT Administrative Instructions, Section 411)

Date of mailing (day/month/year) 29 April 1999 (29.04.99)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference P7117500	
International application No. PCT/GB99/00573	International filing date (day/month/year) 05 March 1999 (05.03.99)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 07 March 1998 (07.03.98)
Applicant THE ENGINEERING BUSINESS LIMITED et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
07 Marc 1998 (07.03.98)	9804770.7	GB	28 Apr 1999 (28.04.99)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

H. Zhou

Telephone No. (41-22) 338.83.38

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum)

Box No. I	TITLE OF INVENTION		
	EXTRACTING POWER FROM MOVING WATER		
Box No. II	APPLICANT		
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.) THE ENGINEERING BUSINESS LIMITED BROOMHAUGH HOUSE RIDING MILL NORTHUMBERLAND NE44 6EG, UNITED KINGDOM		<input type="checkbox"/> This person is also inventor. Telephone No. Facsimile No. Teleprinter No.	
State (that is, country) of nationality: GB		State (that is, country) of residence: GB	
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
Box No. III	FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)		
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.) GRINSTED, TIMOTHY WILLIAM BEAUMONT HOUSE STOCKSFIELD NORTHUMBERLAND NE43 7TN, UNITED KINGDOM		This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
State (that is, country) of nationality: GB		State (that is, country) of residence: GB	
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
<input checked="" type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet.			
Box No. IV	AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE		
The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: <input checked="" type="checkbox"/> agent <input type="checkbox"/> common representative			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) KATE ELLIS (DR) DIBB LUPTON ALSOP FOUNTAIN PRECINCT BALM GREEN SHEFFIELD S1 1RZ UNITED KINGDOM		Telephone No. 0113 241 2962 Facsimile No. 0113 245 2715 Teleprinter No.	
<input type="checkbox"/> Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.			

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

WATCHORN, MICHAEL JOHN
THE OLD COACH HOUSE
HIGH MICKLEY
STOCKSFIELD
NORTHUMBERLAND NE43 7LU
UNITED KINGDOM

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

GB

State (that is, country) of residence:

GB

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☒ AP ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ OA OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|--|--|
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> LS Lesotho |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> LT Lithuania |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> LU Luxembourg |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> LV Latvia |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> MD Republic of Moldova |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> MG Madagascar |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BG Bulgaria | <input checked="" type="checkbox"/> MN Mongolia |
| <input checked="" type="checkbox"/> BR Brazil | <input checked="" type="checkbox"/> MW Malawi |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> MX Mexico |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> NO Norway |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> GE Georgia | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> GH Ghana | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> IN India | |
| <input checked="" type="checkbox"/> IS Iceland | |
| <input checked="" type="checkbox"/> JP Japan | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> KE Kenya | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> KG Kyrgyzstan | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | <input checked="" type="checkbox"/> ZW Zimbabwe |
| <input checked="" type="checkbox"/> KR Republic of Korea | |
| <input checked="" type="checkbox"/> KZ Kazakhstan | |
| <input checked="" type="checkbox"/> LC Saint Lucia | |
| <input checked="" type="checkbox"/> LK Sri Lanka | |
| <input checked="" type="checkbox"/> LR Liberia | |

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- ☒ ALL AVAILABLE STATES
- ☐ PARTY TO PCT ON 5 MARCH 1999

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)


Box No. VI PRIORITY CLAIM		<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.		
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application:* regional Office	international application: receiving Office
item (1) 07.03.1998	9804770.7	UNITED KINGDOM		UNITED KINGDOM
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): (1)

* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY		
Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):	Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):	
ISA /	Date (day/month/year)	Number Country (or regional Office)

Box No. VIII CHECK LIST; LANGUAGE OF FILING	
This international application contains the following number of sheets: request : 4 description (excluding sequence listing part) : 22 claims : 7 abstract : 1 drawings : 13 sequence listing part of description : Total number of sheets : 47	This international application is accompanied by the item(s) marked below: 1. <input checked="" type="checkbox"/> fee calculation sheet 2. <input type="checkbox"/> separate signed power of attorney 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: 4. <input type="checkbox"/> statement explaining lack of signature 5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s): 6. <input type="checkbox"/> translation of international application into (language): 7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material 8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form 9. <input checked="" type="checkbox"/> other (specify): Form 23/77, Fax filing fee sheet x1
Figure of the drawings which should accompany the abstract:	Language of filing of the international application:

Box No. IX SIGNATURE OF APPLICANT OR AGENT	
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).	
 KATE ELLIS (DR)	
5 MARCH 1999	

For receiving Office use only	
1. Date of actual receipt of the purported international application:	2. Drawings: <input type="checkbox"/> received: <input type="checkbox"/> not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
5. International Searching Authority (if two or more are competent): ISA /	
6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.	

For International Bureau use only	
Date of receipt of the record copy by the International Bureau:	

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

ELLIS, K
DIBB LUPTON ALSOP
Fountain Precinct
Balm Green
Sheffield S1 1RZ
GRANDE BRETAGNE

ENTERED BY *SW*

15 MAR 1999

DELIVERED BY

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing
(day/month/year)

09.03.00

Applicant's or agent's file reference
xxx

71175.000

IMPORTANT NOTIFICATION

International application No.
PCT/GB99/00573

International filing date (day/month/year)
05/03/1999

Priority date (day/month/year)
07/03/1998

Applicant

THE ENGINEERING BUSINESS LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer

Diebold, N

Tel. +49 89 2399-2961



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference xxx	FOR FURTHER ACTION		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB99/00573	International filing date (day/month/year) 05/03/1999	Priority date (day/month/year) 07/03/1998	
International Patent Classification (IPC) or national classification and IPC F03B17/06			
Applicant THE ENGINEERING BUSINESS LIMITED et al.			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 06/10/1999	Date of completion of this report 09.03.00
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Fistas, N Telephone No. +49 89 2399 2936 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB99/00573

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-22 as originally filed

Claims, No.:

1-47 with telefax of 22/02/2000

Drawings, sheets:

1/13-13/13 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB99/00573

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Yes: Claims 1-44
	No: Claims
Inventive step (IS)	Yes: Claims 1-44
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-44
	No: Claims

2. Citations and explanations**see separate sheet****VI. Certain documents cited****1. Certain published documents (Rule 70.10)**

and / or

2. Non-written disclosures (Rule 70.9)**see separate sheet****VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB99/00573

1. In new claim 1 the expression "periodically" has been added to specify the reversal in the direction of thrust. However, no basis in the originally-filed application can be found for the above-mentioned expression.

The wording of the new method claim 42 differs from the wording of the method claim 43 as originally filed. With respect to the amendments made in new claim 42, no basis can be recognised for the deletion of the features that "repeatedly reversing the direction of thrust generated by at least one submerged control member protruding from a side of the body".

Section V

2. The invention relates to a prime mover, an apparatus and a method for extracting power from a current of water.

The nearest prior art is e.g. GB-A-1 604 372 identified in the description.

The object of the invention is to provide a prime mover which is ideally suited for extracting energy from flowing water.

Since means for performing actively the reversal in the direction of the thrust even though the direction of the flow of water remains unchanged for such a prime mover, apparatus and method are not contained in any of the prior documents, the subject-matter defined in claim 1, 23 and 42 is new. Furthermore, said subject-matter is considered to be inventive because none of the cited documents or combination thereof contains any hint that could lead in an obvious way to the combination of features described in the independent claims 1, 23 and 42.

The subject-matter of the dependent claims 2-22, 24-41, 43 and 44 are considered to be new and inventive, since they concern particular embodiments of the prime mover, the apparatus and the method defined in claim 1, 23 and 42 respectively.

Section VII

INTERNATIONAL PRELIMINARY

International application No. PCT/GB99/00573

EXAMINATION REPORT - SEPARATE SHEET

3. Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (document GB-A-1 604 372) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).
4. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
5. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents WO-A-87 04401 (D1) and WO-A-80 01674 (D2) are not mentioned in the description, nor are these documents identified therein.
6. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

Section VIII

7. Claims 45, 46 and 47 contain references to the description and/or the drawings. According to Rule 6.2 (a) PCT, claims should not contain such references except where absolutely necessary, which is not the case here. Therefore, these claims should have been deleted.
8. The vague and imprecise statement in the description on page 2, lines 16-20 implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

CLAIMS:

1. A prime mover for extracting power from moving water comprising a body which is caused to oscillate in water
5 by reversing the direction of thrust generated by at least one submerged control member protruding from a side of the body.
2. A prime mover according to claim 1 in which at least one control member protrudes from each side of the body.
- 10 3. A prime mover according to claim 1 or 2 in which the shape of the body is such that water is caused to travel faster over a portion of the surface of the body and in which one or more protruding control members are positioned at that portion of the surface of the body.
- 15 4. A prime mover according to claim 3 in which the body comprises curved sides which orientate the body with respect to the flow of water so that the control member or members are substantially perpendicular to the direction of flow of the moving water.
- 20 5. A prime mover according to any proceeding claim in which the shape of the sides is symmetrical.
6. A prime mover according to claim 3, 4 or 5 in which the sides of the body are convex.
7. A prime mover according to any preceding claim in
25 which at least one second protruding control member is provided fixed with respect to the body and arranged so that when the direction of thrust of a first reversible protruding control member is reversed, the angle of the

second fixed control member with respect to the flow of water is altered so that the action of the water on that second fixed member causes the body to oscillate.

8. A prime mover according to claim 7 in which the
5 fixed second control member is positioned at a point on the body at which the velocity of the water current flowing past the body is at or near a maximum and the first reversible control member is spaced laterally from it in the direction of the water flow.
- 10 9. A prime mover according to any preceding claim in which one, or more control members comprise hydroplanes whereby the direction of thrust is reversed by the angle of inclination of at least one hydroplane.
- 15 10. A prime mover according to any preceding claim in which one or more reversible control members is pivotable in its entirety.
11. A prime mover according to any preceding claim in which one or more reversible control member is pivotable about an edge of that member protruding from the body.
- 20 12. A prime mover according to any preceding claim in which one or more reversible control members is pivotable about a centrally located axis protruding from the body and passing through the member.
- 25 13. A prime mover according to any preceding claim in which one or more of the reversible control members are formed by pivotable flaps mounted to a control member or other mounting means fixed with respect to the body.

14. A prime mover according to any preceding claim in which one or more reversible control members have an aerofoil shape.

5 15. A prime mover according to any preceding claim in which one or more control members comprise a rotatable cylindrical structure, the direction of rotation of which can be reversed so as to cause a change in the direction of thrust generated.

10 16. A prime mover according to any preceding claim in which the distribution of control members on opposing sides of the body is symmetrical.

15 17. A prime mover according to any preceding claim in which the body is elongate and tends to orientate itself so that it is elongate in the direction of flow of the current.

18. A prime mover according to any preceding claim in which the body oscillates in a vertical direction.

20 19. A prime mover according to any preceding claim in which more than one control member is provided on opposing sides of the body.

25 20. A prime mover according to claim 19 in which the control members are spaced along the body in a direction substantially perpendicular to the direction of flow of the water when the body is orientated so that its control members protrude from the body in a direction substantially perpendicular to the direction of flow of water.

21. A prime mover according to claim 20 in which the body is arranged to oscillate vertically and two or more control members are provided on opposing sides of the body in a substantially vertical line.

5 22. A prime mover according to claim 20 or 21 in which three or more control members are provided on each side and the separation of the control members is substantially equal.

23. Apparatus for extracting power from moving water
10 comprising a prime mover according to any preceding claim.

24. Apparatus according to claim 23 in which the prime mover is connected to mooring means secured or securable under water.

15 25. Apparatus according to claim 23 or 24 in which the prime mover is connected to mooring cable.

26. Apparatus according to any of claims 23 to 25 in which the prime mover is axially slidably mounted or mountable to a column secured or securable under water in
20 an upright position.

27. Apparatus according to claim 26 in which the prime mover comprises a downwardly extending tube which surrounds the column.

28. Apparatus according to any of claims 23 to 27 in
25 which power conversion means are provided for converting the oscillations of the prime mover into another form of power such as electrical power.

29. Apparatus according to any of claims 23 to 28 in which the prime mover is submerged when generating power.

30. Apparatus according to any of claims 23 to 29 in which power conversion means are provided comprising one
5 or more hydraulic pumps, a crank arrangement, or means for generating electricity, such as an electric coil and magnet.

31. Apparatus according to any of claims 23 to 29 in which power conversion means are provided comprising a
10 fluid pump for pumping fluid to a higher level to store potential energy.

32. Apparatus according to any claims 23 to 31 moored to or mounted on a structure such as a column on which apparatus for extracting power from wind is mounted.

15 33. Apparatus according to any of claims 23 to 32 in which the prime mover is buoyant.

34. Apparatus according to any of claims 23 to 33 in which the prime mover comprises an open bottomed tank which when it oscillates alternately compresses and
20 decompresses a fluid inside it between a closed top of the tank and the water surface.

35. Apparatus according to claim 34 in which at least one duct in the top of the tank permits the fluid alternately to flow out of and into the tank.

25 36. Apparatus according to claim 35 in which the fluid flowing through one or more ducts drives a turbine.

37. Apparatus according to claim 36, in which two or

more ducts are provided and the number of ducts selected can be varied and/or in which the size of one or more ducts can be varied.

38. Apparatus according to claim 36 or 37 in which a turbine is housed in a duct.

39. Apparatus according to any of claims 36 to 38 in which the turbine rotates in the same direction irrespective of the flow of fluid out of or into the tank.

40. Apparatus according to any of claims 36 to 38 in which valve means are provided so that fluid passes through the turbine in the same direction irrespective of the flow of fluid out of or into the tank.

41. Apparatus according to any of claims 35 to 40 in which the turbine is directly drivably connected to an electrical generator.

42. Apparatus according to any of claims 34 to 40 in which the fluid is air.

43. A method for extracting power from moving water comprising:

providing a prime mover as described in any of claims 1 to 42;

repeatedly reversing the direction of thrust generated by at least one submerged control member protruding from a side of the body.

44. A method according to claim 43, in which a control

member comprises a hydroplane whose angle of inclination can be reversed.

45. A method according to claim 43, in which a control member comprises a rotating cylindrical member whose
5 direction of rotation can be reversed.

46. A prime mover substantially as described herein with reference to and/or as illustrated in the accompanying figures.

47. Apparatus for extracting power from moving water
10 substantially as described herein with reference to and/or as illustrated in the accompanying figures.

48. A method for extracting power from moving water substantially as described herein with reference to and/or as illustrated in the accompanying figures.

The demand must be filed directly with the competent International Preliminary Examining Authority if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ _____

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CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA		Date of receipt of DEMAND
Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION		Applicant's or agent's file reference
International application No. PCT/GB99/00573	International filing date (day/month/year) 05 March 1999	(Earliest) Priority date (day/month/year) 07 March 1998
Title of invention Extracting Power from Moving Water		
Box No. II APPLICANT(S)		
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) THE ENGINEERING BUSINESS LIMITED BROOMHAUGH HOUSE RIDING MILL NORTHUMBERLAND NE44 6EG UNITED KINGDOM		Telephone No.: Facsimile No.: Teleprinter No.:
State (that is, country) of nationality: GB	State (that is, country) of residence: GB	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) GRINSTED, TIMOTHY WILLIAM BEAUMONT HOUSE STOCKSFIELD NORTHUMBERLAND NE43 7TN, UNITED KINGDOM		
State (that is, country) of nationality: GB	State (that is, country) of residence: GB	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) WATCHORN, MICHAEL JOHN THE OLD COACH HOUSE HIGH MICKLEY STOCKSFIELD NORTHUMBERLAND NE43 7LU UNITED KINGDOM		
State (that is, country) of nationality: GB	State (that is, country) of residence: GB	
<input type="checkbox"/> Further applicants are indicated on a continuation sheet.		

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCEThe following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

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☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:***

1. The applicant wishes the international preliminary examination to start on the basis of:

☒ the international application as originally filed

the description ☐ as originally filed
☐ as amended under Article 34

the claims ☐ as originally filed
☐ as amended under Article 19 (together with any accompanying statement)
☐ as amended under Article 34

the drawings ☐ as originally filed
☐ as amended under Article 34

2. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English☒ which is the language in which the international application was filed.☐ which is the language of a translation furnished for the purposes of international search.☐ which is the language of publication of the international application.☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.**Box No. V ELECTION OF STATES**

The applicant hereby elects all eligible States (that is, all States which have been designated and which are bound by Chapter II of the PCT)

excluding the following States which the applicant wishes not to elect:

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- | | | |
|--|---|--------|
| 1. translation of international application | : | sheets |
| 2. amendments under Article 34 | : | sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4. copy (or, where required, translation) of statement under Article 19 | : | sheets |
| 5. letter | : | sheets |
| 6. other (specify) | : | sheets |

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received not received

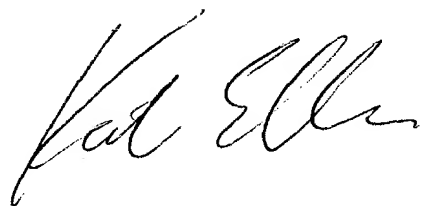
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The demand is also accompanied by the item(s) marked below:

- | | |
|--|---|
| 1. <input checked="" type="checkbox"/> fee calculation sheet | 4. <input type="checkbox"/> statement explaining lack of signature |
| 2. <input type="checkbox"/> separate signed power of attorney | 5. <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6. <input type="checkbox"/> other (specify): |

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).



Kate Ellis (Dr), European Patent Attorney

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1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply.

☐ The applicant has been informed accordingly.

4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.

5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

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FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

International application No. PCT/GB99/00573	For International Preliminary Examining Authority use only
Applicant's or agent's file reference P71175WO	Date stamp of the IPEA
Applicant <div style="text-align: center; font-size: 1.2em;">The Engineering Business Limited</div>	
Calculation of prescribed fees	
1. Preliminary examination fee EURO	<div style="border: 1px solid black; display: inline-block; padding: 2px 10px;">1533.00</div> <div style="border: 1px solid black; display: inline-block; padding: 2px 5px; margin-left: 5px;">P</div>
2. Handling fee (<i>Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.</i>)	<div style="border: 1px solid black; display: inline-block; padding: 2px 10px;">148.00</div> <div style="border: 1px solid black; display: inline-block; padding: 2px 5px; margin-left: 5px;">H</div>
3. Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box	<div style="border: 1px solid black; display: inline-block; padding: 2px 10px;">EURO 1681.00</div> <div style="border: 1px solid black; display: inline-block; padding: 2px 10px; margin-top: 5px;">TOTAL</div>
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<u>Kate Ellis</u> Signature	

PATENT COOPERATION TREATY

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents
United States Patent and Trademark
Office
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Washington, D.C. 20231
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in its capacity as elected Office

Date of mailing (day/month/year) 03 November 1999 (03.11.99)	
International application No. PCT/GB99/00573	Applicant's or agent's file reference
International filing date (day/month/year) 05 March 1999 (05.03.99)	Priority date (day/month/year) 07 March 1998 (07.03.98)
Applicant GRINSTED, Timothy, William et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

06 October 1999 (06.10.99)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Marc Salzman
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(74) Agent: ELLIS, Kate; Dibb Lupton Alsop, Fountain Precinct, Balm Green, Sheffield S1 1RZ (GB).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

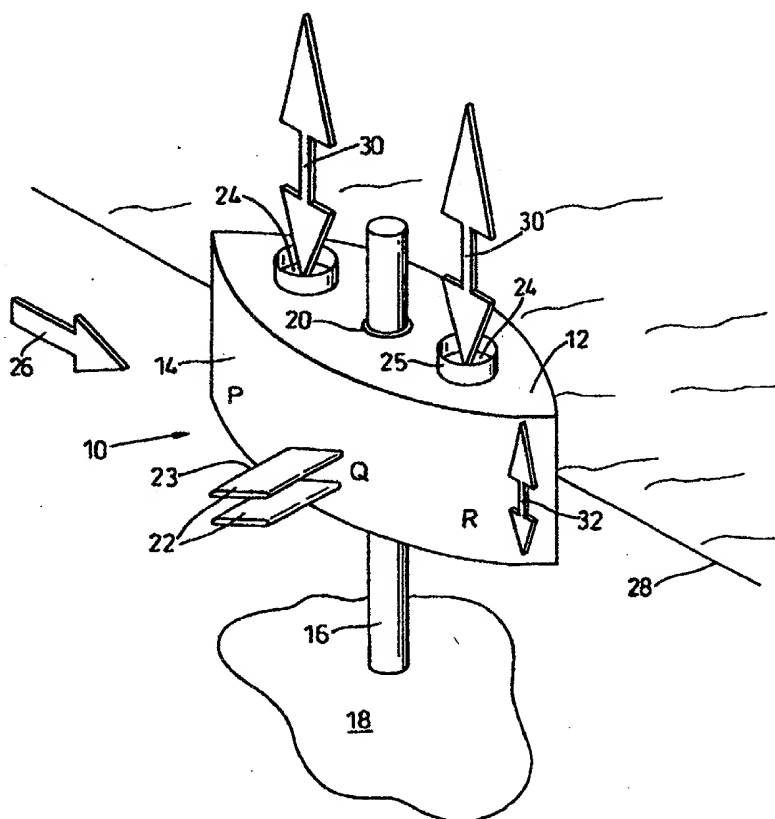
Published

With international search report.

(54) Title: EXTRACTING POWER FROM MOVING WATER

(57) Abstract

A prime mover for extracting power from moving water is described comprising a body which is caused to oscillate in water by reversing the direction of thrust generated by at least one submerged control member e.g. a hydroplane or rotating cylinder protruding from a side of the body. Preferably, the prime mover comprises an open bottomed tank which when it oscillates alternately compresses and decompresses a fluid inside it between a closed top of the tank and the water surface. Preferably the fluid is air. Other energy removal schemes can be combined with the prime mover to generate power.



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(51) International Patent Classification ⁶ : F03B 17/06, F03D 5/06	A1	(11) International Publication Number: WO 99/45268
		(43) International Publication Date: 10 September 1999 (10.09.99)

With international search report.

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EXTRACTING POWER FROM MOVING WATERBackground of the Invention

5 This invention relates to a prime mover, an apparatus and method for extracting power from moving water such as tidal flows and river currents.

Hitherto, this has generally been proposed or achieved by means of turbines analogous to underwater windmills. The
10 blades of these windmills rotate as a result of the water flow about a horizontal or vertical axis at low speeds of the order of 10 to 30 revolutions per minute and at high torque. Gearboxes are required to transfer rotation at such speeds to the high speeds required for electrical
15 generators. The gearboxes are large, complex and expensive with high power losses. The gearboxes also suffer from reliability problems and are difficult to maintain, particularly when located under water.

GB1604372 discloses a device for utilising tidal energy
20 which comprises two cylindrical tank members fitting slidably inside one another. The device is supported on a tripod resting on the seabed. A flotation collar renders the outer tank buoyant so that it rises and falls with the water level as a result of which air within the
25 tanks is compressed by their relative movement. Connections provided in the cover of the inner tank allow the compressed air to be used to drive an air turbine situated at a remote location.

The current invention aims to provide a prime mover (for
30 converting natural energy into mechanical power), an

apparatus and a method for transferring kinetic energy from slow moving water. The prime mover can be used with any suitable energy removal scheme. For example it can be used to produce electrical energy directly or to
5 provide a useful form of mechanical movement. In a further aspect of the invention, kinetic energy from slow moving water is transferred into kinetic energy of a fluid travelling at high speed. Preferably the fluid is air.

10 According to a first aspect of the invention there is provided a prime mover for extracting power from moving water comprising a body which is caused to oscillate relative to the water by reversing the direction of thrust generated by at least one submerged control member
15 protruding from a side of the body.

Whilst this prime mover is ideally suited for extracting energy from flowing water, extraction from other flowing fluids is possible and the term "water" should be interpreted as covering other flowing liquids and gases
20 throughout this document.

Preferably, at least one control member protrudes from each side of the body.

Preferably, the shape of the body is such that water is caused to travel faster over a portion of the surface of
25 the body and in which one or more protruding control members are positioned at that portion of the surface of the body.

Preferably, the body comprises curved sides which orientate the body with respect to a flow of water so

that the control member or members are substantially perpendicular to the direction of flow of the moving water.

Preferably, the control member(s) is generally planar.

5 Preferably, the shape of the sides is symmetrical.

Preferably, the sides of the body are convex.

Preferably, at least one second protruding control member is provided fixed with respect to the body and arranged so that when the direction of thrust of a first
10 reversible protruding control member is reversed, the angle of the second fixed control member with respect to the flow of water is altered so that the action of the water on that second fixed member. Thus the control member acts like a tail plane of an aircraft.

15 Preferably, the fixed second control member is positioned at a point on the body at which the velocity of the water flowing past the body is at or near a maximum.

Preferably, the first reversible control member is spaced laterally from it in the direction of the water flow.

20 Preferably, the reversible control member is downstream of the fixed control member. This is much like a tail plane on an aircraft.

Preferably, one or more control members comprise hydroplanes whereby the direction of thrust is reversed
25 by reversing the angle of inclination of at least one hydroplane.

Preferably, the distribution of control members on

opposing sides of the body is symmetrical.

Preferably, the body is elongate and tends to orientate itself so that it is elongate in the direction of flow of the current.

5 Preferably, the body oscillates in a vertical direction.

Preferably, one or more reversible controls members are pivotable in its entirety.

Preferably, one or more reversible control member are pivotable about an edge protruding from the body.

10 Preferably, one or more reversible control members are pivotable about a central axis protruding from the body.

Preferably, one or more of the reversible control members are formed by a pivotable flap mounted to a control member or other mounting means fixed with respect to the
15 body.

Preferably, one or more reversible control members have an aerofoil shape.

In a further embodiment, one or more control members comprise a rotatable cylindrical structure whose
20 direction of rotation can be reversed to generate a change in direction of thrust. As an example, the cylindrical structure may form a continuous cylinder or may have spaced vanes.

Preferably, more than one control member is provided on
25 opposing sides of the body.

Preferably, the control members are spaced along the body

in a direction substantially perpendicular to the direction of flow of the water when the body is orientated so that its control members protrude from the body in a direction substantially perpendicular to the
5 direction of flow of water.

Preferably, the body is arranged to oscillate vertically and two or more control members are provided on opposing sides of the body spaced in a substantially vertical line.

10 Preferably, three or more control members are provided on each side and the separation of the control members is substantially equal.

According to a further aspect there is provided, apparatus for extracting power from moving water
15 comprising a prime mover as described herein.

Preferably, the prime mover is connected to mooring means secured or securable under water.

Preferably, the prime mover is connected to mooring cable.

20 Preferably, the prime mover is axially slidably mounted or mountable to a column secured or securable under water in an upright position.

Preferably, the prime mover comprises a downwardly extending tube which surrounds the column.

25 Preferably, power conversion means are provided for converting the oscillations of the prime mover into another form of power such as electrical power.

Preferably, the prime mover is submerged when generating power.

Preferably, power conversion means are provided comprising one or more hydraulic pumps, a crank for
5 generating mechanical rotation or means for generating electricity such as an electric coil and magnet.

Preferably, power conversion means are provided comprising a fluid pump for pumping fluid to a higher level.

10 Preferably, the apparatus is moored to or mounted on a structure such as column on which apparatus for extracting power from wind or wave is mounted. Thus, the prime mover extracts power from tidal or river current flow, and power is also extracted from wind or waves.

15 Whilst the prime mover is ideally suited to extracting power from tidal and river currents, it is also adaptable to be used for extracting power from waves as will be explained below in connection with a preferred embodiment.

20 Preferably, the prime mover is buoyant. Typically, it will float on the surface with part of its structure below the surface.

Preferably, the prime mover comprises an open bottomed tank which when it oscillates alternately compresses and
25 decompresses a fluid inside it between a closed top of the tank and the water surface.

It will be understood by those skilled in the art from the information disclosed herein that the inventions in

this preferred embodiment can operate in two modes.

In the first mode, power is extracted from tidal and river flows in the following way. As water flows past the control member, upward and downward thrust is produced causing the prime mover to move in a plane which crosses the flow direction (typically it is roughly perpendicular). Reversing the control member causes the direction of thrust to be reversed and when this is repeated the prime mover reciprocates generally in the plane.

This reciprocating movement can be converted into a more useful form of energy by an appropriate energy removal arrangement. In this preferred embodiment the prime mover is a tank which alternately compresses and decompresses a fluid.

In the second mode, power is extracted from waves. As waves impinge on the tank, the water level inside it rises and falls relative to the top of the collector. Vertical movement of the tank is damped by the drag of the hydroplanes. This drag can be supplemented, though this is not always necessary, by reversing the control member or members to produce thrust in a direction opposite to the rise and fall of water in the waves. Thus the tank tends to remain stationary relative to a fixed point, the shore or sea bed say, but the fluid inside the tank is alternately compressed and decompressed by the action of the waves.

Preferably, at least one duct in the top of the tank permits the fluid alternately to flow out of and into the

tank.

Preferably, the fluid flowing through one or more ducts drives a turbine. Preferably, the turbine is mounted on the tank. Thus, the turbine operates in air when the fluid chosen is air. Preferably, the turbine is directly drivably connected to an electrical generator. Preferably, the number and/or size of ducts open at any time, or selected to drive a selected turbine at a particular time, can be varied so that the flow of air can be optimised to the efficiency requirements of the turbine.

Preferably, a turbine is housed in a duct. Preferably, a generator, or combined turbine and generator is housed in the duct.

Preferably, the turbine rotates in the same direction irrespective of the flow of fluid out of or into the tank.

Preferably, valve means are provided so that fluid passes through the turbine in the same direction irrespective of the flow of fluid out of or into the tank.

Preferably, the fluid is air.

In a further aspect there is provided a method of extracting power from moving water comprising repeatedly reversing the direction of thrust generated by a submerged control member protruding from a body in a prime mover as described herein.

Preferred embodiments of the invention will now be described, by way of example only, with reference to the

accompanying drawings as follows:

Figure 1 is a perspective view of an active water column apparatus installed in working position for extracting power from moving water.

5 Figure 2 is a plan view of the apparatus of Figure 1.

Figure 3 shows eight cross-sectional views (A-H) showing the operating cycle of the apparatus.

Figure 4 is a graph showing hydroplane movement, air pressure and hydroplane acceleration as a function of
10 time during the operating cycle.

Figure 5 shows a number of repeated cycles similar to those in Figure 4.

Figure 6 is a plan view of an alternative embodiment of the invention showing several air exhaust/inlet ducts.

15 Figure 7 is a cross-sectional view through the apparatus of Figure 6 showing its mooring on a monopile.

Figure 8 shows plan and cross-sectional views of a cable moored apparatus.

Figures 9A and 9B shows cross-sectional views through
20 alternative hydroplanes of the apparatus in accordance with the invention.

Figure 10 is a schematic elevation view of one side of an apparatus according to the invention showing fixed hydroplanes at a central location and rotatable tail
25 hydroplanes located, in this preferred embodiment, towards the rear of the apparatus vis a vis the flow

direction of the water.

Figure 11 is a perspective view of a tank according to the invention showing optional elongated bearings used to mount the tank to a monopile. Spaced ring bearings may
5 also be used as shown in cross section in figure 7.

Figure 12 shows a schematic side view of a tank detailing the use of control members as water reflectors rather than hydroplanes.

Figure 13 shows a plan view of a tank according to the
10 invention moored by cables when tidal flow in and out are at 180 degrees and moored by a monopile when tidal flow is at an angle β between inward and outward flows.

Figure 14 shows plan and cross-sectional views of apparatus for generating power from a prime mover
15 according to the invention using a hydraulic cylinder when moored to a monopile support column.

Figure 15 is similar to figure 14 but a control/generating box is floating beneath the surface and moored by cables.

20 Figure 16 shows plan and cross-sectional views of apparatus for generating mechanical power from a submerged prime mover moored on a monopile support column. The apparatus can be rearranged in a similar manner to that of figure 15, ie. utilising a
25 control/generating box submerged and moored by cables.

Figure 17 shows a schematic elevation view of apparatus for generating electricity directly using a prime mover.

Figure 18 shows a schematic elevation view of apparatus for pumping water to a higher level for storage of potential energy. Typically, the water is the same as that flowing past the tank 10.

5 Figure 19 shows a schematic perspective view of an alternative tank in accordance with the invention.

In figure 1, a large buoyant or floating open bottomed tank 10 contains air as a working fluid (see 17 in figure 3). Tank 10 has a substantially flat top 12 and is canoe shaped in plan view. The convex sides 14 of tank 10 meet to provide a pointed edge. The sides serve to orientate the tank so that the pointed edge points into the flow so that water passes over convex sides 14. Thus, water travels over sides 14 between points P, Q and R. At 15 point Q the flow of water is generally homogenous and is typically faster than the flow of water at points P and R because of the constriction produced by the widening of the tank at that point. This is a suitable point at which to place hydroplanes 22 protruding from sides 14, 20 the kinetic of the water energy available to be extracted being proportional to the cube of the velocity of the flow. Therefore the hydroplanes are advantageously located at this point of maximum velocity.

Tank 10 typically comprises a downwardly extending tube 25 (not shown) which slidably surrounds a support column 16 secured underwater, usually to the sea or river bed 18, in an upright position. Typically, a large diameter plane bearing 20 is secured in the top of the tube and a similar bearing (not shown) is secured in the bottom of 30 the tube so that the two bearings are widely spaced

apart. Thus, said bearings are slidable axially and rotateably relative to the column 16. Further bearing strips 20 may be provided as an alternative or in addition to the circular bearings as shown in figure 11.

5 Hydroplanes 22 are submerged and pivotable in their entirety, typically about a lower edge 23, about an axis generally perpendicular to sides 14 of the tank. The two upper hydroplanes 22 on opposite sides 14 of the tank are interconnected by a shaft (not shown) and the two lower
10 hydroplanes are likewise interconnected. The inclination of the hydroplanes 22 is reversible in unison by partially rotating the associated shafts, for example by hydraulic or mechanical means. Such change in the inclination of the hydroplanes is typically under
15 computerised control and in response to several parameters. These parameters include motion of the tank, water flow direction, forces on the hydroplanes and/or air pressure in the tank. As will be explained below, the optimum arrangement is such that air is virtually
20 always flowing into or out of the tank. The energy within the tank at a given time is equivalent to the air pressure times the air volume. The energy available to be collected is equivalent to the volume change over a given time period times the pressure differential over
25 the same period.

The maximum angle of inclination of the hydroplanes 22 is also adjustable. Whilst hydroplanes 22 typically act as hydroplanes causing lift by the action of water flowing over their upper and lower surfaces, control members 22
30 can be caused to act as water deflectors much in the same

way that a kite deflects air. This is shown in figure 12 and will be described in further detail later.

Two ducts 25 are formed in the top 12 of tank 10. These ducts house high speed air turbines and, optionally, also
5 generators which are directly drivable by the flow of air into and out of the tank and can supply rotation directly to the electrical generators (not shown) wherever these are located. Turbines 24, and the generators, need not
10 therefore be located underwater but are working in air enhancing reliability and ease of maintenance. Valve means (not shown) can be provided in each duct so that air passes through each turbine 24 in the same direction
15 irrespective of the flow of air into or out of the tank. Alternatively, a special turbine such a Wells turbine is used, such turbines always turn in the same direction
irrespective of the direction of air flow.

In operation, the shape and in particular the convex sides 14 of tank 10 automatically orientate it like a
20 weather vane so that control members 22 are kept substantially at right angles to the water current indicated by arrow 26. This orientation reduces drag on the tank and increases the velocity of the current
passing along particularly the widest most portion of the sides and therefore over hydroplanes 22.

25 The action of water current 26 on hydroplanes 22 causes the tank to move upwards and downwards on column 16 depending upon the inclination, for the time being, of the hydroplanes. Thus, the tank is caused to oscillate as indicated by arrow 32 so as to alternately compress
30 (as it moves downwards) and decompress (as it moves

upwards) the air contained inside it between top 12 and water surface 28.

As tank 10 moves downwards the pressure differential causes air to be expelled through the ducts. During the
5 downward part of the cycle, the downward force from hydroplanes 22 and the weight of the tank opposes the buoyancy forces, ie upthrust of the water on the tank. This can be seen in steps a and b of figure 3. The air pressure inside the tank is greater than atmospheric
10 pressure outside and causes a small change h in the level of water inside the tank compared to the level of water outside the tank. This head of water coupled with further downward movement of the tank by virtue of the angle of inclination of the hydroplanes causes the
15 continued pressure differential inside and outside the tank. Air 30 is expelled from the tank via ducts 25. As can be seen in figures 4 and 5, at $T=T1$ air commences to be expelled from the tank. This continues until $T=T3$ when the downward forces on the tank are balanced by the
20 upward forces of water, head h of water is lost and the pressure inside the tank equals atmospheric pressure. At this point flow 30 ceases. It is desirable that the length of time spent at this point is kept to a minimum.

Therefore, towards the bottom of the movement and
25 preferably before too long is spent at the bottom of the movement, the inclination of the hydroplanes 22 is caused to reverse so that these exert a vertical upward force. Tank 10 is accelerated upwards by a combination of this force and its buoyancy (see step E in figure 3).

As the tank moves upwards, the pressure within it falls below atmospheric and a small head of water h is developed compared to the level of water outside the tank. Air is drawn in through the ducts (see step F).

- 5 At the top of the movement the head of water h disappears and the pressure inside the tank again reaches atmospheric.

Thus, if the distance of the tank above water surface 28 at rest is X_1 and below water surface 28 is X_2 then at
10 step G, the top of the motion, X_1 has increased in relation to X_2 .

In the measurements shown in figure 4 there is no peak in the pressure measurement to indicate air flowing in to the tank because of the limitation of the measuring
15 equipment. Nevertheless, air was observed to flow into the tank during the period indicated.

The cycle is repeated beginning again with hydroplanes 22 being inclined in the other direction with respect to current 26.

- 20 The velocity of the air passing through the turbines can be varied by changing the size and/or the number of ducts. Thus, in figure 6, of the six ducts shown, one or more of these may be closed off or otherwise removed from the flow of air so that the velocity of air passing
25 through the remaining ducts is increased. Thus the size and/or number of the ducts can be varied so customising a particular apparatus for a particular location (since current flows vary from location to location) or for particular conditions. Indeed, several ducts can be

diverted through a single turbine, so that it operates in its most effective range for power generation, when water flow is slow, and rediverted to several ducts (and hence several turbines) when water flow is fast. Typically, 5 the air turbines also comprise a generator located in the ducts. The velocity of air passing through the turbines can also be varied by changing the number and/or size of the hydroplanes. This ability to customise the tank to location and the prevailing conditions allows it to 10 operate at optimum or near optimum efficiency in given circumstances.

Since the tank 10 floats and is slidable relative to column 16 it is self-adjusting to changes in the height of water surface 28. Furthermore, since it can rotate on 15 monopile 16 it is self-adjusting to changes in the direction of water flow. This can be particularly important for tidal flows where inward and outward tidal flows are not at approximately 180 degrees to each other. This is shown in detail in figure 13 in which cables 33 20 can be used to moor tank 10 on monopiles 25 when inward and outward flow are in substantially opposite directions or in river flows. A limited amount of rotation can be possible when using mooring cables if the attachment points of the cables are designed for this. However, a 25 central monopile 16 is typically used to mount tank 10 when inward and outward flows are at angle β with respect to one another. This allows rotation of tank 10 by angle β to align itself with the prevailing tidal flow.

The angle of inclination of the hydroplanes relative to 30 the direction and speed of the water current governs the

magnitude of lift and drag forces on the tank. Thus, typically control members 22 function as hydroplanes acting as hydroplanes generating lift but little drag. In figure 12, water flow 26 is redirected downwards by control member 22d causing tank 10 to move in the direction of arrow 32. This is similar to the way that a kite maintains its height. Control member 22D is rotated through a vertical plane about a horizontal axis to cause the tank 10 to reverse its direction of motion. Control members 22D can however cause drag so their use may be limited to particular circumstances where drag is not a problem, such as when firm cable moorings are available.

Adjustment of the angle of hydroplanes or control members 22d such as those in figure 12 can allow for maximum power output over a wide range of current speeds. Thus there are several variables as described above which can be optimised to increase the efficiency and power output of the apparatus. Furthermore, the apparatus can be connected to shore by a power cable and can be submersible during storms thereby reducing the risk of damage.

Figure 6 shows control members 22C and 22B which typically function as hydroplanes operating over an angular range of 5 to 30 degrees, for example, 2α equals around 60 degrees. The frequency with which the planes are reversed is typically 5 to 20 seconds, but may be less than or more than this. The angular orientation of the hydroplanes in a working position is selected from a range of angular working positions.

Hydroplanes 22a are located on the widest portion of tank 10. Alternative or further hydroplanes 22B and 22C can be located at other points though this is less preferred. Hydroplanes 22B are equally spaced whereas hydroplanes 22c are not equally spaced. By locating hydroplanes in a vertical direction, one above the other, roughly perpendicular to the water flow the turbulence flow produced downstream does not interfere with its neighbours. Thus, typically one of the series 22A and 22B and 22C, is selected rather than having hydroplanes spaced along the tank in the direction of flow of the water. The hydroplanes may be staggered, i.e. spaced vertically but overlapping in a horizontal direction such as hydroplanes 22E in figure 8.

Figure 8 also shows a tank similar to that in figure 6 and 7 but moored by cables 33 to a suitable mooring point either above or below water level. Figure 9A shows two symmetrical cross-sections, one more aerodynamic than the other, for use as hydroplanes and one aerofoil cross-section for use as hydroplane. Typically, symmetrical shapes are preferred and aerodynamic shapes are preferred most of all.

Figure 10 shows fixed hydroplanes 22 which do not rotate with respect to member 10. Rotatable tail hydroplanes 34 cause the tank to rise or fall. Once this rise has begun, it slightly tilts the tank so that hydroplanes 22 are now at an angle with respect to water flow 26 thus adding to the forces causing the tank to rise or fall. Other hydroplanes, or mounting structures, fixed with respect to the tank on which reversible hydroplanes are mounted

may be used. These resemble pivotal flaps on aeroplane wings. A further type of hydroplane suitable for use with the invention is shown in Fig. 9B. Here, hydroplane 22F shown in cross section is flexible and can be flexed
5 so that its curvature is inverted (reversed) causing lift 32A or downward thrust 32B as appropriate.

Figures 14 to 18 show the use of a prime mover 40 mounted about a monopile 16 or moored via cables 33 and provided with hydroplanes 22 causing prime mover 40 to rise or
10 fall on the reverse of these hydroplanes. Several different kinds of power conversion means are provided for converting the oscillating motion of prime mover 40 into usable forms of power, whether this is water stored at a higher level, mechanical rotation, electrical power,
15 hydraulic power and so on. Whist tank 10 is typically buoyant, prime mover 40 is typically partially buoyant so that it is submerged when at rest. Prime mover 40 rises and falls in exactly the same way as tank 10 by reversing the inclination of hydroplanes 22 or control members 22D
20 as previously described. Thus, prime mover 40 oscillates up and down in the direction of arrow 32.

In figure 14, a hydraulic piston pumps fluid within a control chamber 40 to generate power or connects to a crank

25 In figure 15 a similar hydraulic pump 42 is used though in this case control chamber 44 is located beneath the surface and is moored to the sea bed by cables 33. Thus, the prime mover 40 here floats above the sea bed. Typically column 16A, about which prime mover 40 is
30 located, comprises slots through which members mounted on

prime mover 40 project to drive pump 42 so causing the piston in hydraulic apparatus 42 to rise and fall. Also column 16A is open to the surface to permit access to the control and generating chamber 44 and so that power can
5 be extracted for example by cables.

In figure 16 shaft 42a rises and falls causing a crank system 43 to generate mechanical rotation which can be converted into electrical power or caused to drive a turbine.

10 In figure 17 struts 46 carry a coil 48 and move up and down in the direction of arrow 32 along with prime mover 40. Coil 48 is positioned about a magnet 50 to provide directly an ac current directly.

In figure 18, water is pumped by hydraulic apparatus 42
15 and pipe 52 into an elevated storage chamber 54. The water falls back via pipe 56 and can be used to generate electrical power in water turbine 58.

In figure 19, an alternative embodiment uses rotating cylinders to generate upward and downward thrust.
20 Cylinders 61 rotate in the direction of arrow 62 with respect to current 26. The cylinders produce drag 62 but also a downward force 60, or an upward force when rotation is reversed. Whilst rotation may be produced by driving connecting rod 64 using electricity, current 26
25 may be used to provide the necessary rotation via rotating wheel 70 which via connecting means 68 and gear box 66 causes rod 64 to rotate. A windmill type wheel rotating about a horizontal axis (not shown) could also be used. The gear box could be used to produce the

reversal in rotation 63 without changing the direction of motion of rotating wheel 70.

Thus, the invention provides not only an apparatus for converting slow moving water or other suitable fluids
5 (both gases and liquids) into fast moving air so that rotational speeds of 1,000 to 3,000 revolutions per minute in turbines can be generated, but also prime movers which can be combined with any appropriate energy removal system. Suitable liquids or other gases can be
10 used in place of air. The fast moving fluid is typically lighter than the fluid from which power is extracted. The tank can be non-buoyant or of neutral buoyancy. The tank or prime mover can be orientated by power driven means instead of like a weather vane. One or more rudders or
15 other vertical control surfaces may be provided to aid the orientation of the tank. These may be power driven but could be manually set for example on each tide change. The tank and the prime mover can be located permanently under water. The tank can have a shape
20 different from that shown. A single tank or several tanks may be used.

The apparatus can be used to provide power for an associated desalination plant. One further arrangement is for a combined apparatus responsive to tidal flows,
25 waves and windpower is provide. For example, a wind turbine mounted on top of a support column could be used. Thus power generation is derivable from the action of wave energy on the prime mover, especially when the prime mover is a tank, tidal flows on the prime mover and wind
30 power from the wind turbine mounted on top of the support

column. Power generation is possible from the action of waves on one of the control surfaces providing resistance to the bobbing motion of the tank under the influence of the waves. Power generation from waves incident on the

5 semi buoyant collector cause the water inside the collector level to rise and fall relative to the top of the collector. Vertical movement of the collector is damped by the drag of the hydroplanes. The force of the moving water in the wave cycle pushing against the

10 hydroplanes can cause the collector to move in opposite phase to the water inside the collector so causing the fluid in it to be alternately compressed and decompressed. The angle of the hydroplanes can be altered to increase this effect of the waves passing into

15 the collector. The apparatus can incorporate means for storage of energy or can be used to provide power for an autonomous device such as a buoy. A further embodiment may include two prime movers such as tanks 10 with one or more hydroplanes extending between the prime movers.

20 This offers stability to the hydroplanes since both ends of each hydroplane are supported by the tanks.

Control members in the form of hydroplanes and rotating cylindrical structures (whether hollow, solid or vanes spaces about roughly cylindrical periphery and so on) can

25 be used in combination on a prime mover of the invention. The prime mover may be arranged to oscillate horizontally. The angle of inclination, need not be the same for the upward and downward parts of this cycle (eg to take account of the weight of the prime mover).

CLAIMS:

1. A prime mover for extracting power from moving water comprising a body which is caused to oscillate in water
5 by reversing the direction of thrust generated by at least one submerged control member protruding from a side of the body.
2. A prime mover according to claim 1 in which at least one control member protrudes from each side of the body.
- 10 3. A prime mover according to claim 1 or 2 in which the shape of the body is such that water is caused to travel faster over a portion of the surface of the body and in which one or more protruding control members are positioned at that portion of the surface of the body.
- 15 4. A prime mover according to claim 3 in which the body comprises curved sides which orientate the body with respect to the flow of water so that the control member or members are substantially perpendicular to the direction of flow of the moving water.
- 20 5. A prime mover according to any proceeding claim in which the shape of the sides is symmetrical.
6. A prime mover according to claim 3, 4 or 5 in which the sides of the body are convex.
7. A prime mover according to any preceding claim in
25 which at least one second protruding control member is provided fixed with respect to the body and arranged so that when the direction of thrust of a first reversible protruding control member is reversed, the angle of the

second fixed control member with respect to the flow of water is altered so that the action of the water on that second fixed member causes the body to oscillate.

8. A prime mover according to claim 7 in which the
5 fixed second control member is positioned at a point on the body at which the velocity of the water current flowing past the body is at or near a maximum and the first reversible control member is spaced laterally from it in the direction of the water flow.

10 9. A prime mover according to any preceding claim in which one, or more control members comprise hydroplanes whereby the direction of thrust is reversed by the angle of inclination of at least one hydroplane.

15 10. A prime mover according to any preceding claim in which one or more reversible control members is pivotable in its entirety.

11. A prime mover according to any preceding claim in which one or more reversible control member is pivotable about an edge of that member protruding from the body.

20 12. A prime mover according to any preceding claim in which one or more reversible control members is pivotable about a centrally located axis protruding from the body and passing through the member.

25 13. A prime mover according to any preceding claim in which one or more of the reversible control members are formed by pivotable flaps mounted to a control member or other mounting means fixed with respect to the body.

14. A prime mover according to any preceding claim in which one or more reversible control members have an aerofoil shape.

5 15. A prime mover according to any preceding claim in which one or more control members comprise a rotatable cylindrical structure, the direction of rotation of which can be reversed so as to cause a change in the direction of thrust generated.

10 16. A prime mover according to any preceding claim in which the distribution of control members on opposing sides of the body is symmetrical.

15 17. A prime mover according to any preceding claim in which the body is elongate and tends to orientate itself so that it is elongate in the direction of flow of the current.

18. A prime mover according to any preceding claim in which the body oscillates in a vertical direction.

20 19. A prime mover according to any preceding claim in which more than one control member is provided on opposing sides of the body.

25 20. A prime mover according to claim 19 in which the control members are spaced along the body in a direction substantially perpendicular to the direction of flow of the water when the body is orientated so that its control members protrude from the body in a direction substantially perpendicular to the direction of flow of water.

21. A prime mover according to claim 20 in which the body is arranged to oscillate vertically and two or more control members are provided on opposing sides of the body in a substantially vertical line.

5 22. A prime mover according to claim 20 or 21 in which three or more control members are provided on each side and the separation of the control members is substantially equal.

23. Apparatus for extracting power from moving water
10 comprising a prime mover according to any preceding claim.

24. Apparatus according to claim 23 in which the prime mover is connected to mooring means secured or securable under water.

15 25. Apparatus according to claim 23 or 24 in which the prime mover is connected to mooring cable.

26. Apparatus according to any of claims 23 to 25 in which the prime mover is axially slidably mounted or mountable to a column secured or securable under water in
20 an upright position.

27. Apparatus according to claim 26 in which the prime mover comprises a downwardly extending tube which surrounds the column.

28. Apparatus according to any of claims 23 to 27 in
25 which power conversion means are provided for converting the oscillations of the prime mover into another form of power such as electrical power.

29. Apparatus according to any of claims 23 to 28 in which the prime mover is submerged when generating power.

30. Apparatus according to any of claims 23 to 29 in which power conversion means are provided comprising one
5 or more hydraulic pumps, a crank arrangement, or means for generating electricity, such as an electric coil and magnet.

31. Apparatus according to any of claims 23 to 29 in which power conversion means are provided comprising a
10 fluid pump for pumping fluid to a higher level to store potential energy.

32. Apparatus according to any claims 23 to 31 moored to or mounted on a structure such as a column on which apparatus for extracting power from wind is mounted.

15 33. Apparatus according to any of claims 23 to 32 in which the prime mover is buoyant.

34. Apparatus according to any of claims 23 to 33 in which the prime mover comprises an open bottomed tank which when it oscillates alternately compresses and
20 decompresses a fluid inside it between a closed top of the tank and the water surface.

35. Apparatus according to claim 34 in which at least one duct in the top of the tank permits the fluid alternately to flow out of and into the tank.

25 36. Apparatus according to claim 35 in which the fluid flowing through one or more ducts drives a turbine.

37. Apparatus according to claim 36, in which two or

more ducts are provided and the number of ducts selected can be varied and/or in which the size of one or more ducts can be varied.

38. Apparatus according to claim 36 or 37 in which a
5 turbine is housed in a duct.

39. Apparatus according to any of claims 36 to 38 in which the turbine rotates in the same direction irrespective of the flow of fluid out of or into the tank.

10 40. Apparatus according to any of claims 36 to 38 in which valve means are provided so that fluid passes through the turbine in the same direction irrespective of the flow of fluid out of or into the tank.

15 41. Apparatus according to any of claims 35 to 40 in which the turbine is directly drivably connected to an electrical generator.

42. Apparatus according to any of claims 34 to 40 in which the fluid is air.

20 43. A method for extracting power from moving water comprising:

providing a prime mover as described in any of claims 1 to 42;

repeatedly reversing the direction of thrust generated by at least one submerged control member
25 protruding from a side of the body.

44. A method according to claim 43, in which a control

member comprises a hydroplane whose angle of inclination can be reversed.

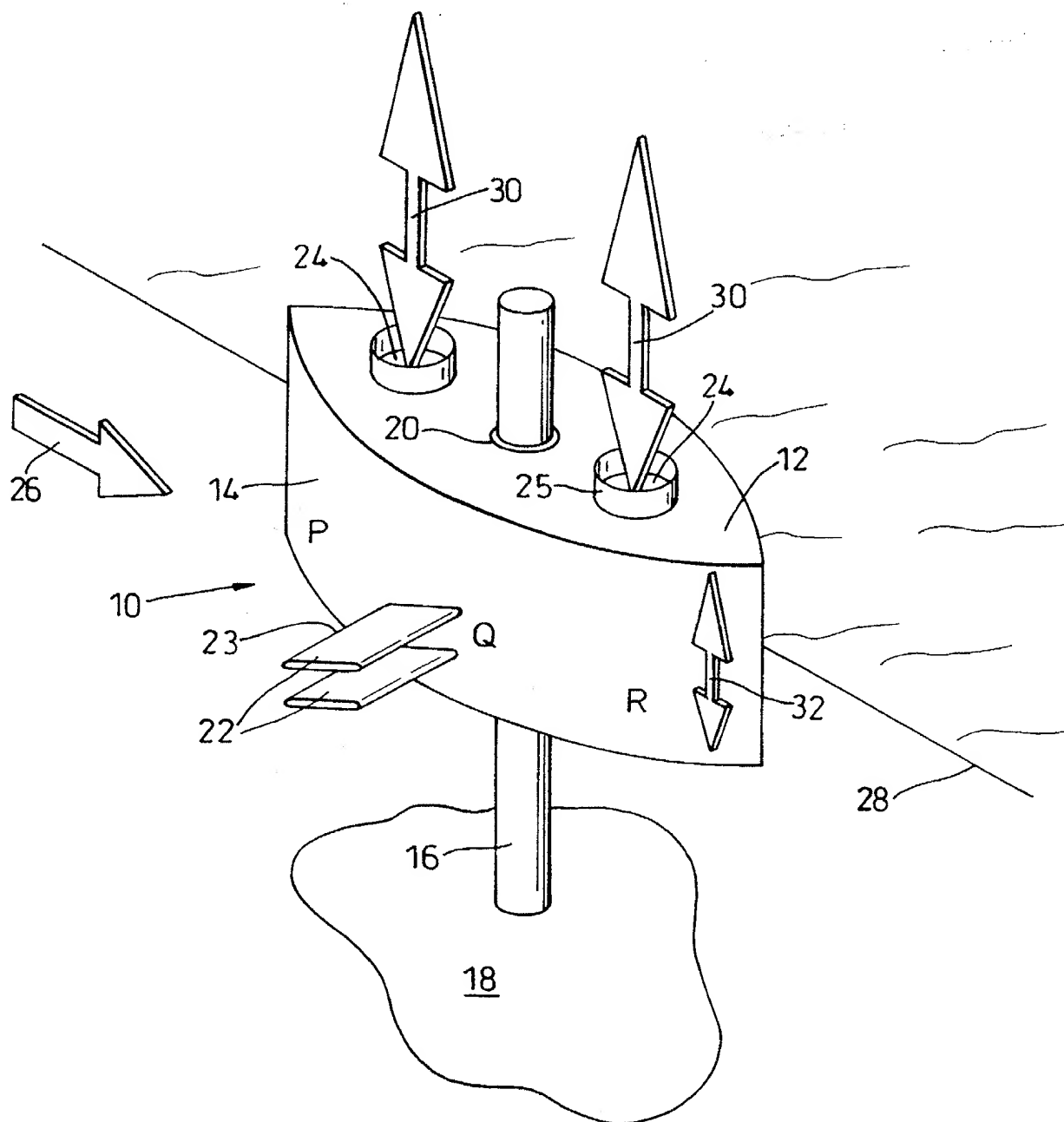
45. A method according to claim 43, in which a control member comprises a rotating cylindrical member whose
5 direction of rotation can be reversed.

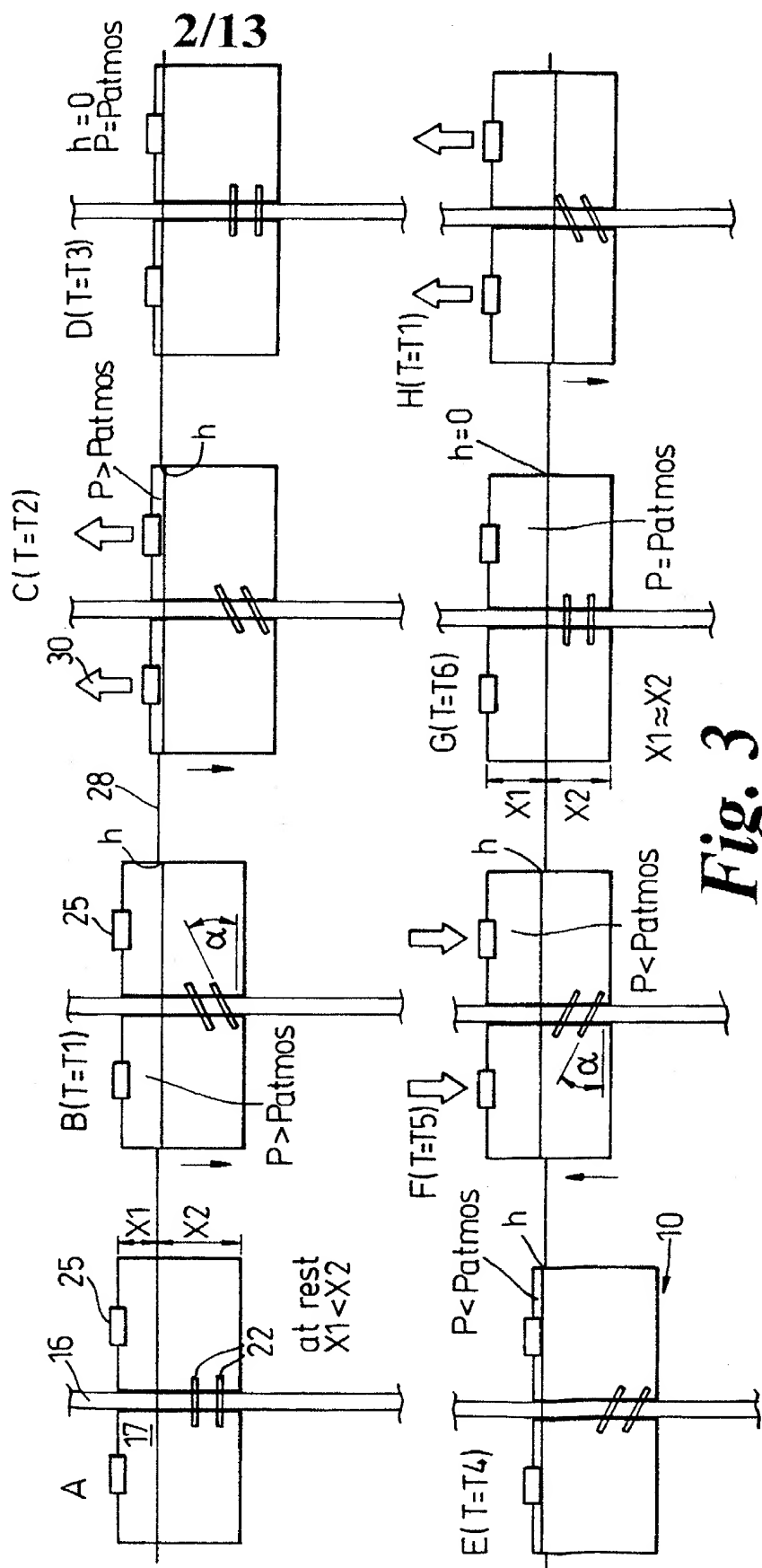
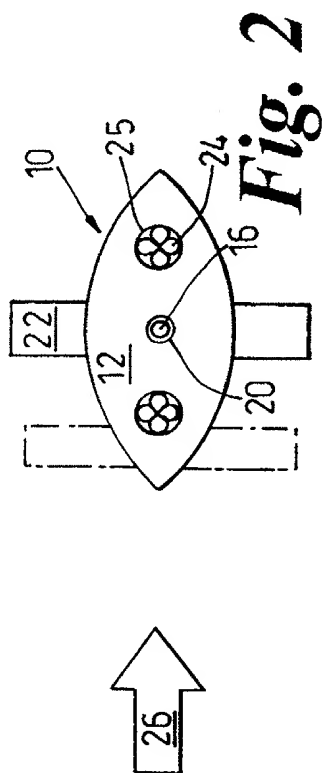
46. A prime mover substantially as described herein with reference to and/or as illustrated in the accompanying figures.

47. Apparatus for extracting power from moving water
10 substantially as described herein with reference to and/or as illustrated in the accompanying figures.

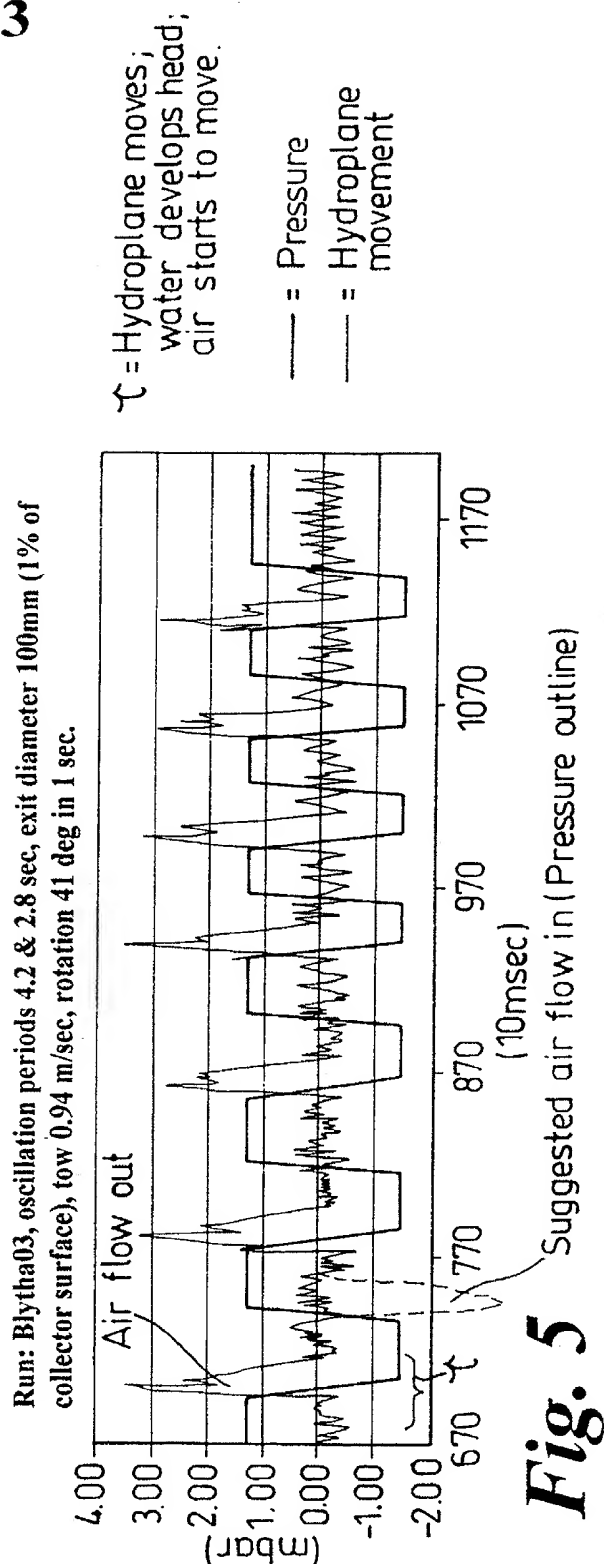
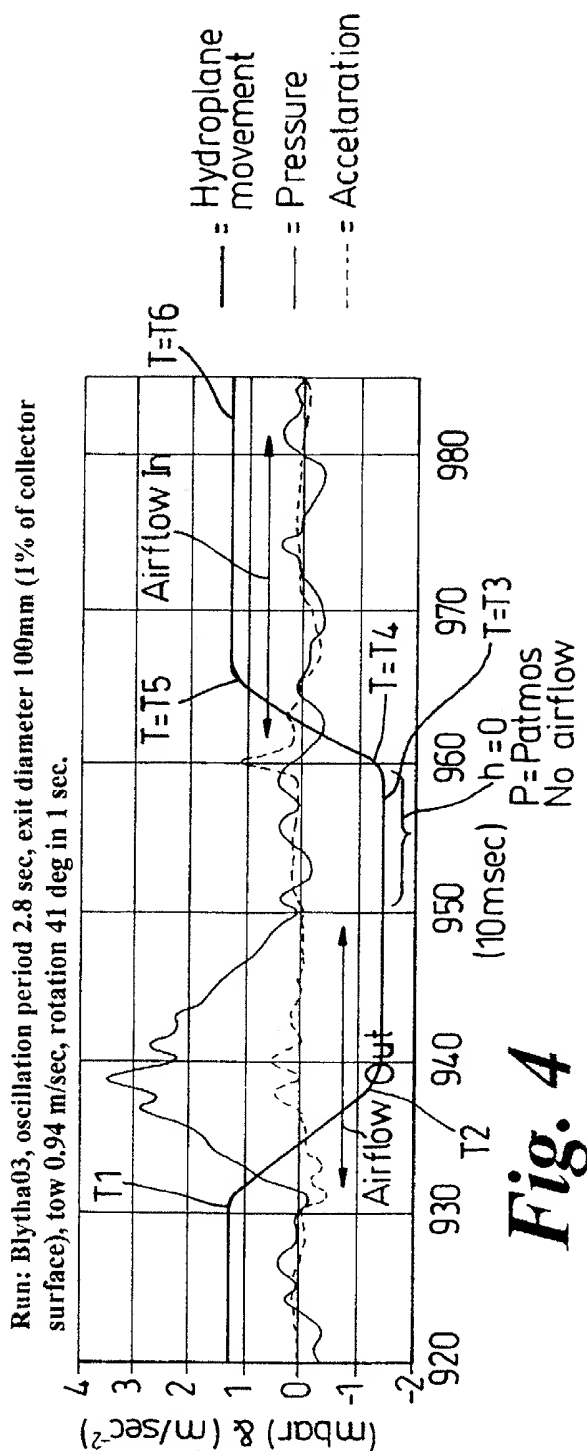
48. A method for extracting power from moving water substantially as described herein with reference to and/or as illustrated in the accompanying figures.

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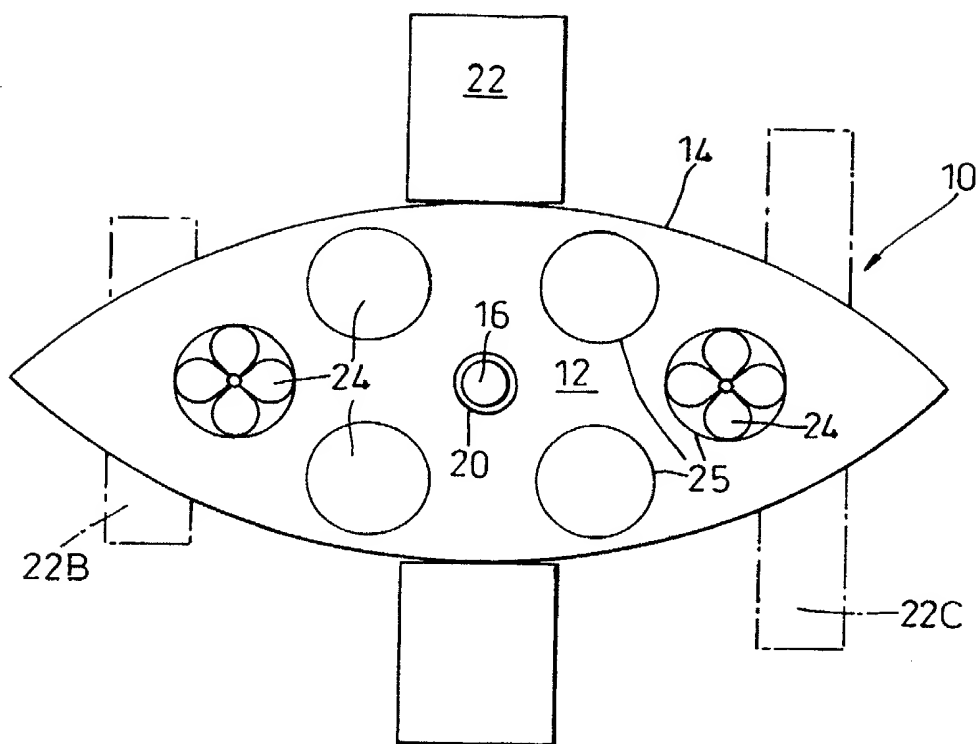
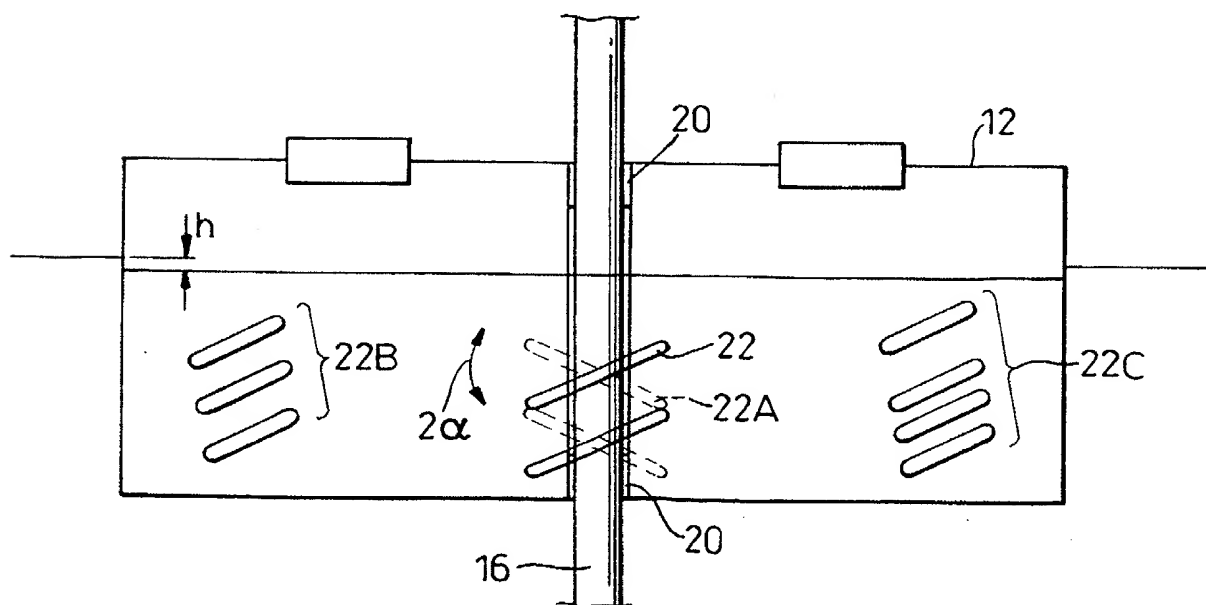
**Fig. 1**



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**Fig. 6****Fig. 7**

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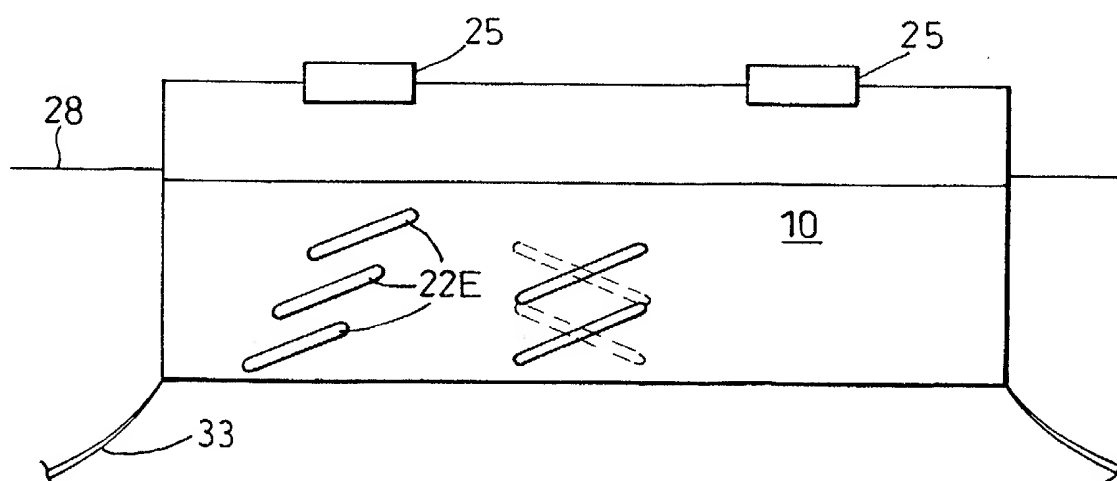
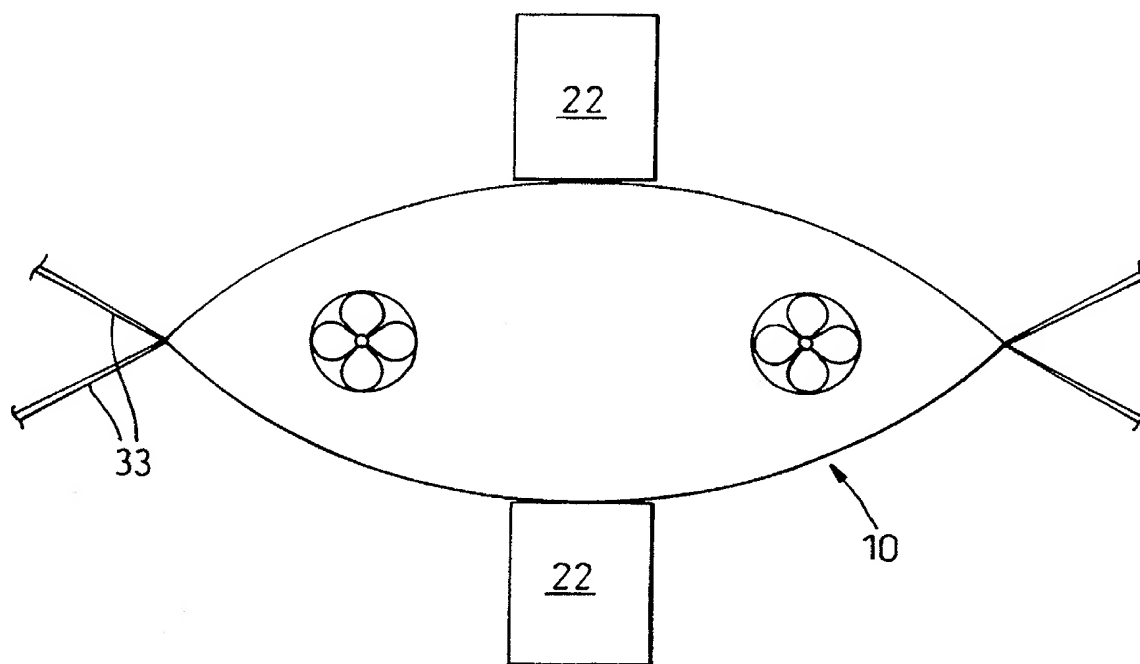
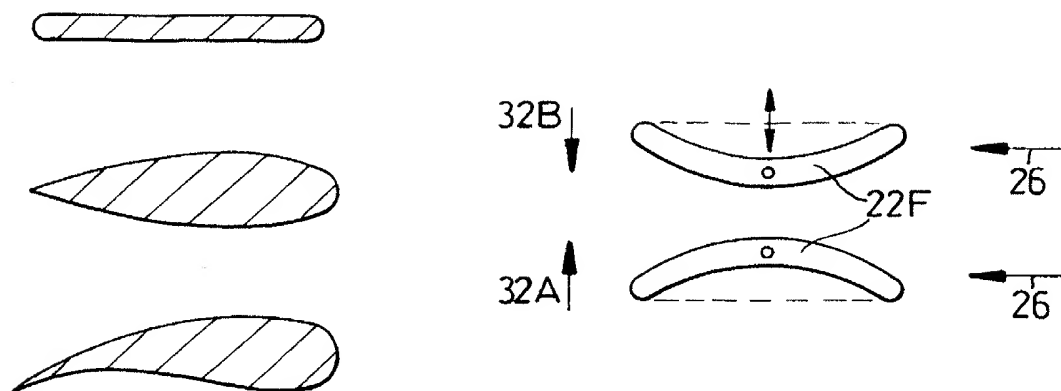
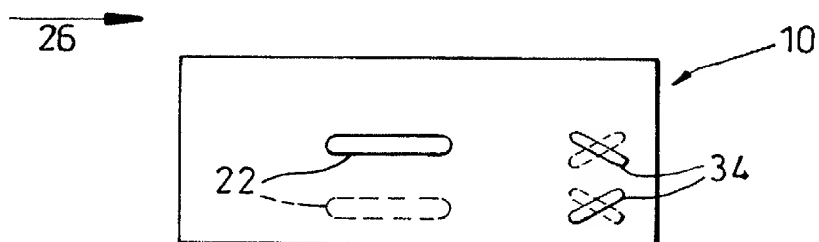
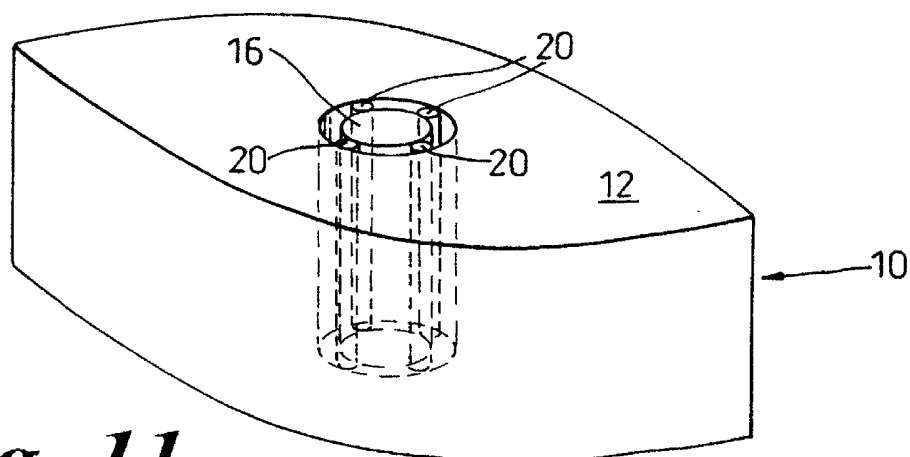


Fig. 8

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**Fig. 9A****Fig. 9B****Fig. 10****Fig. 11**

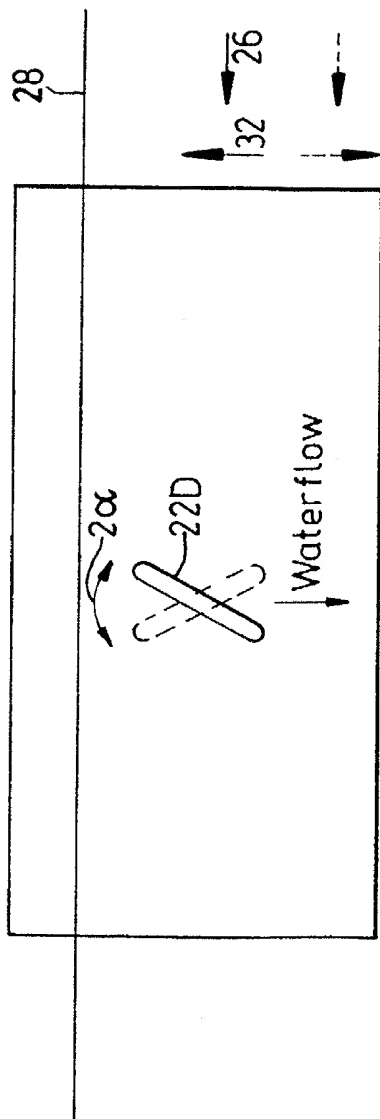


Fig. 12

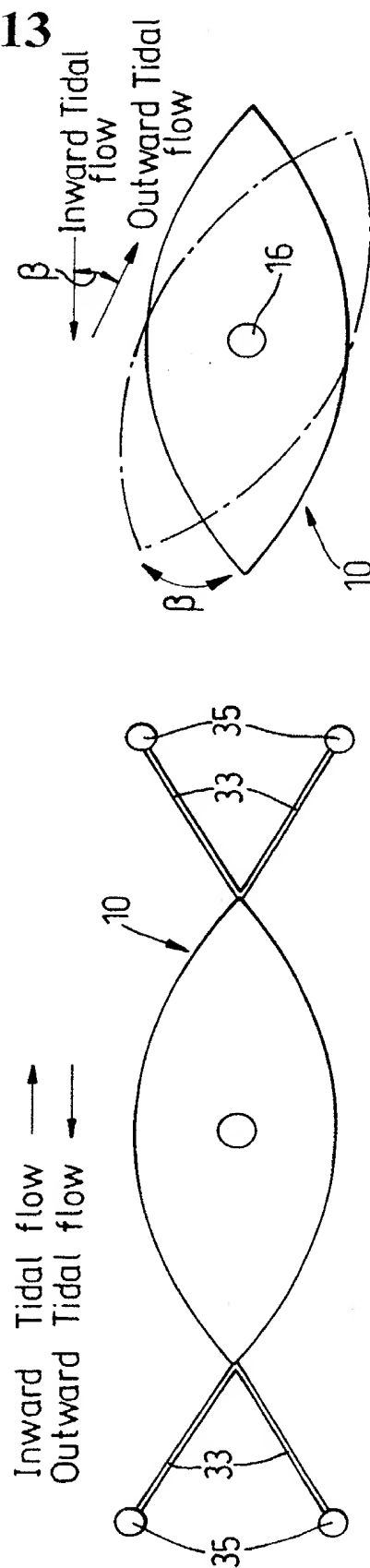


Fig. 13

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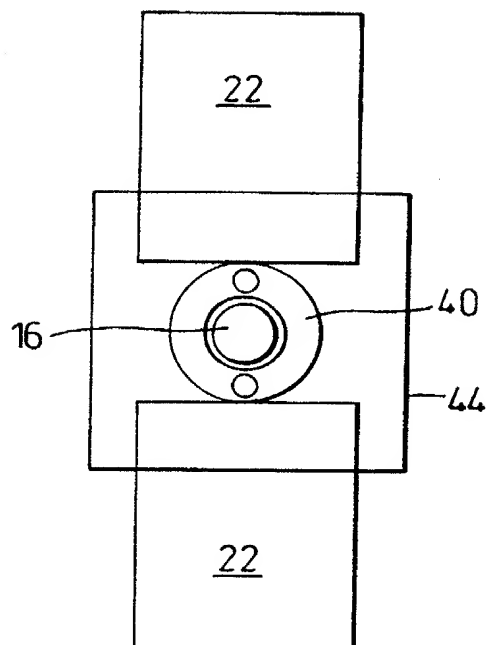
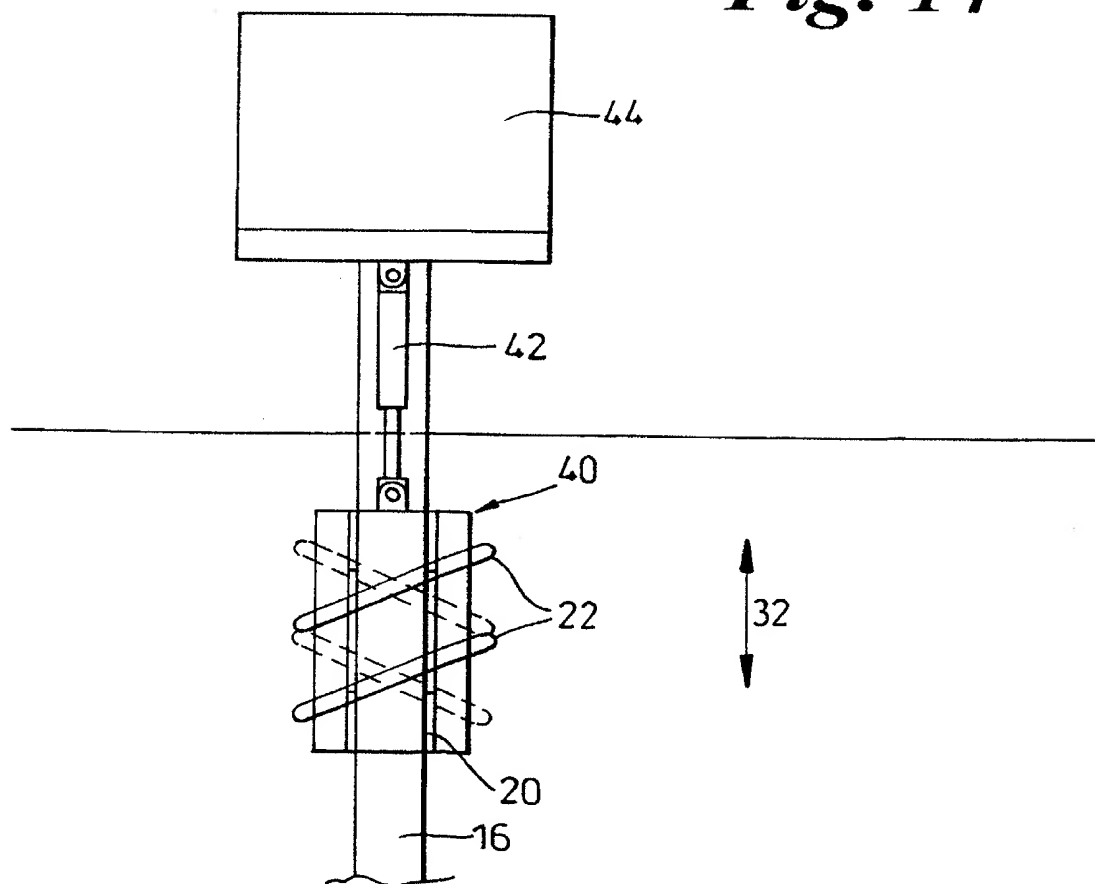


Fig. 14



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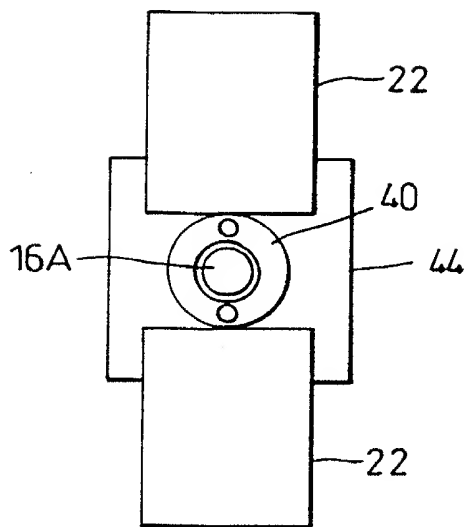
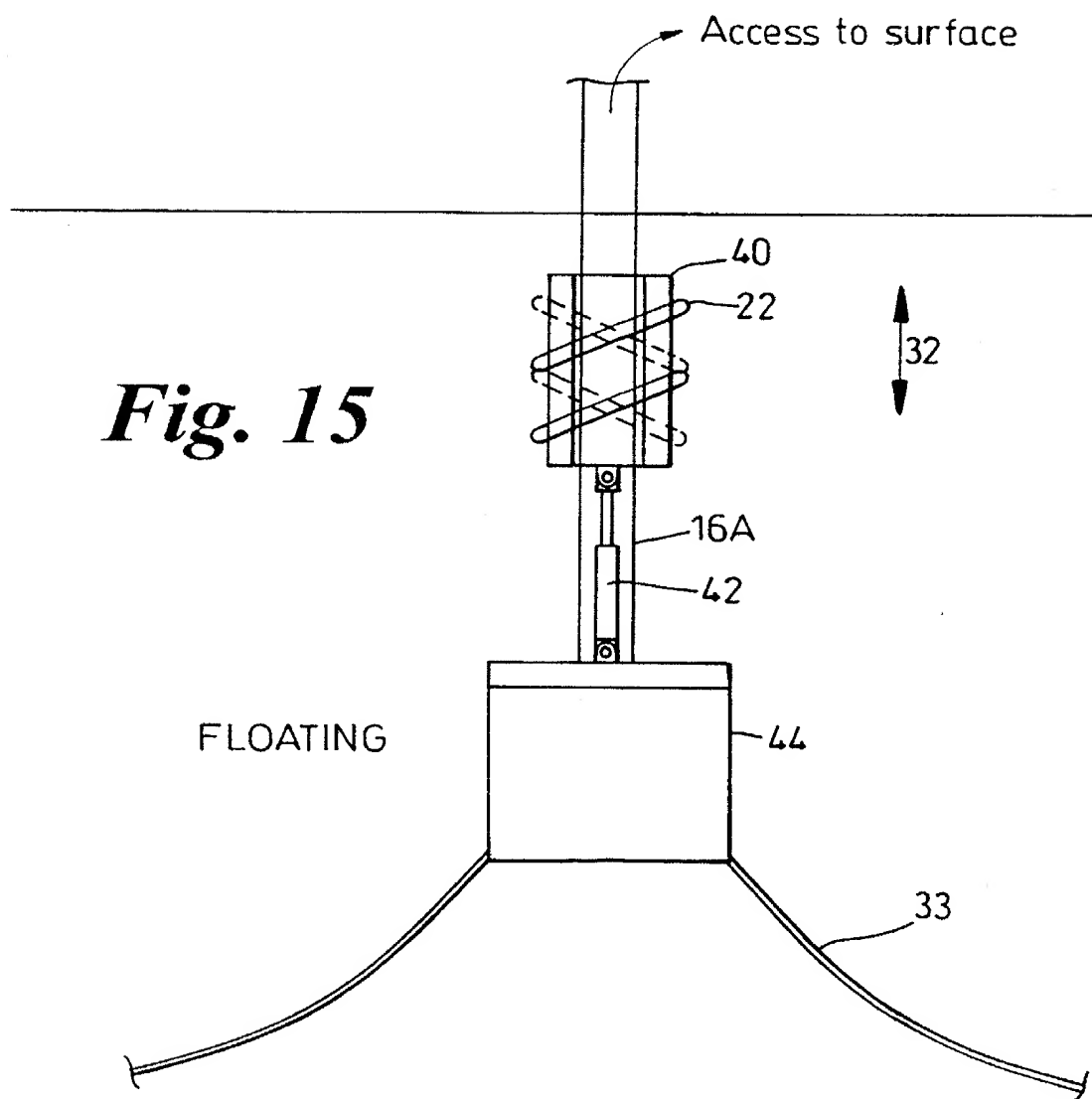


Fig. 15



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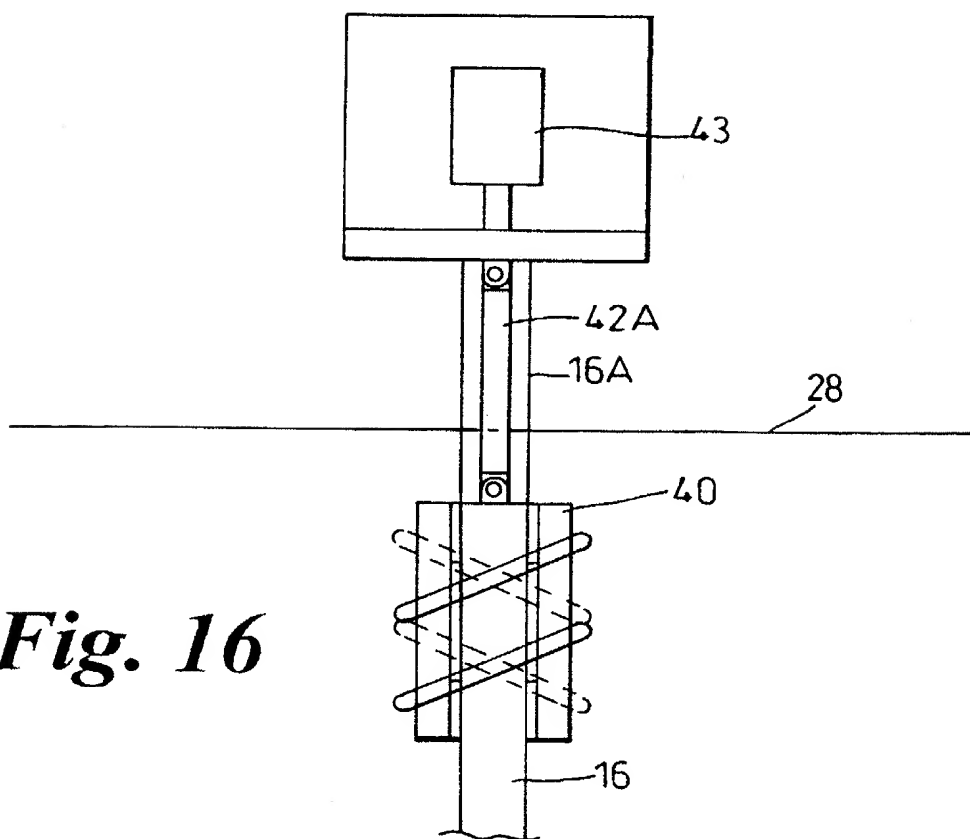
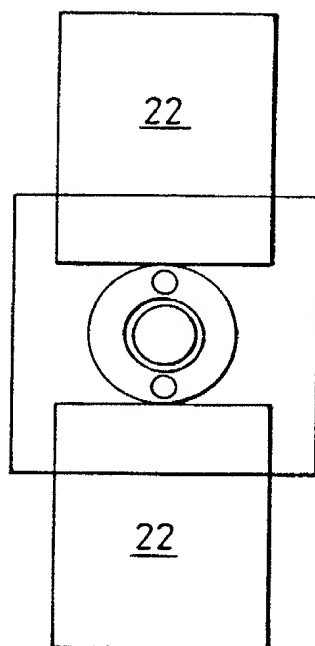
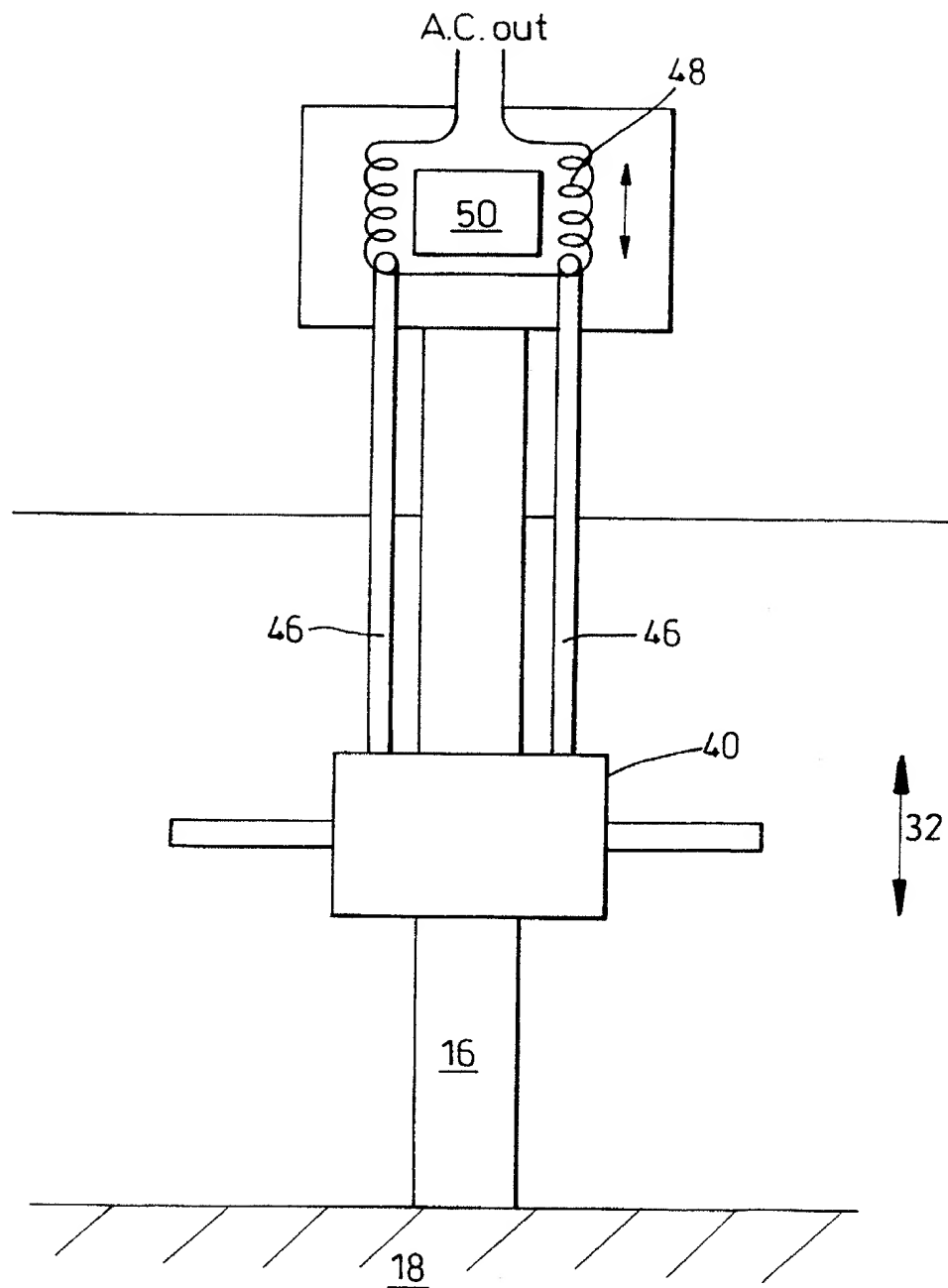


Fig. 16

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***Fig. 17***

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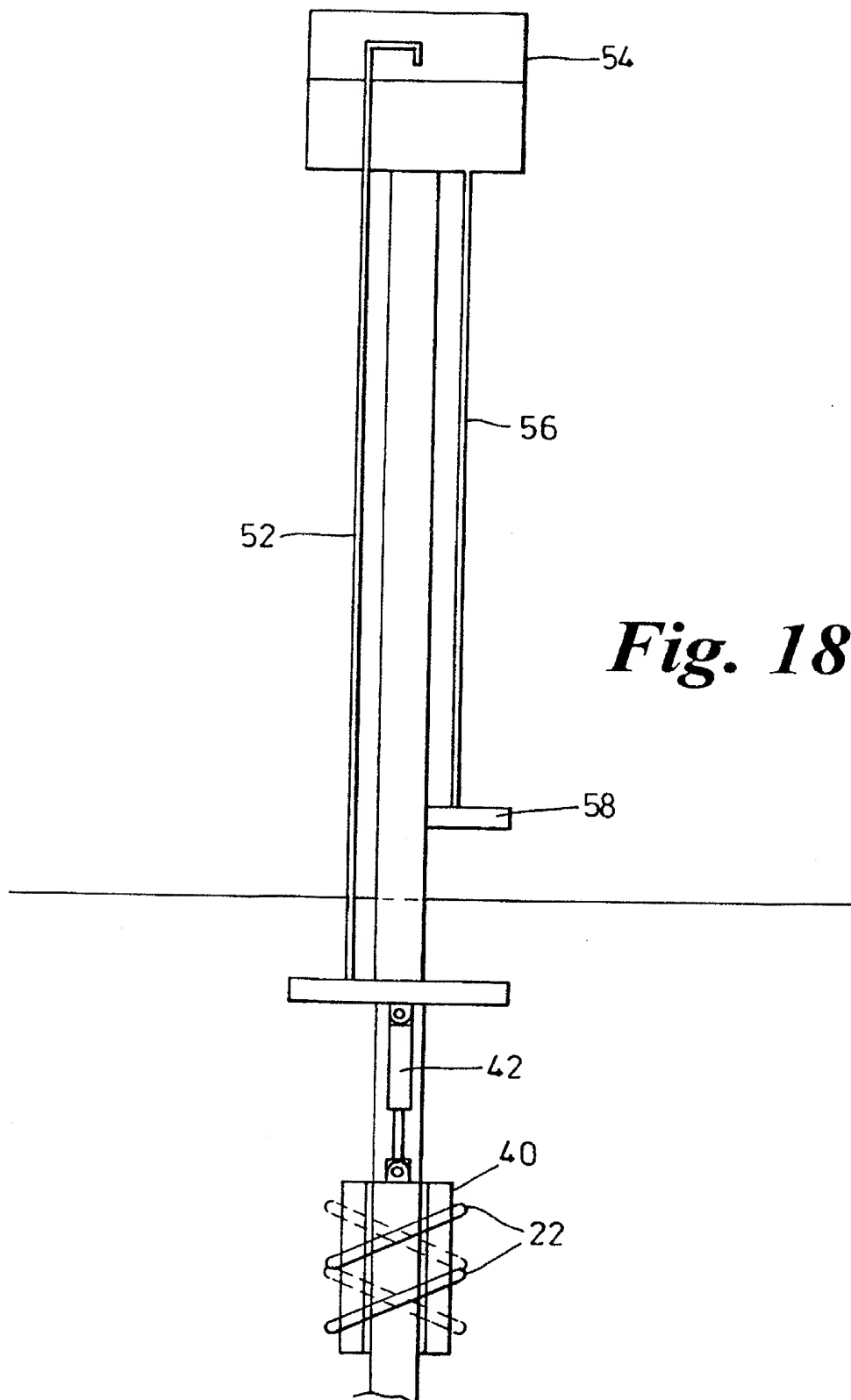
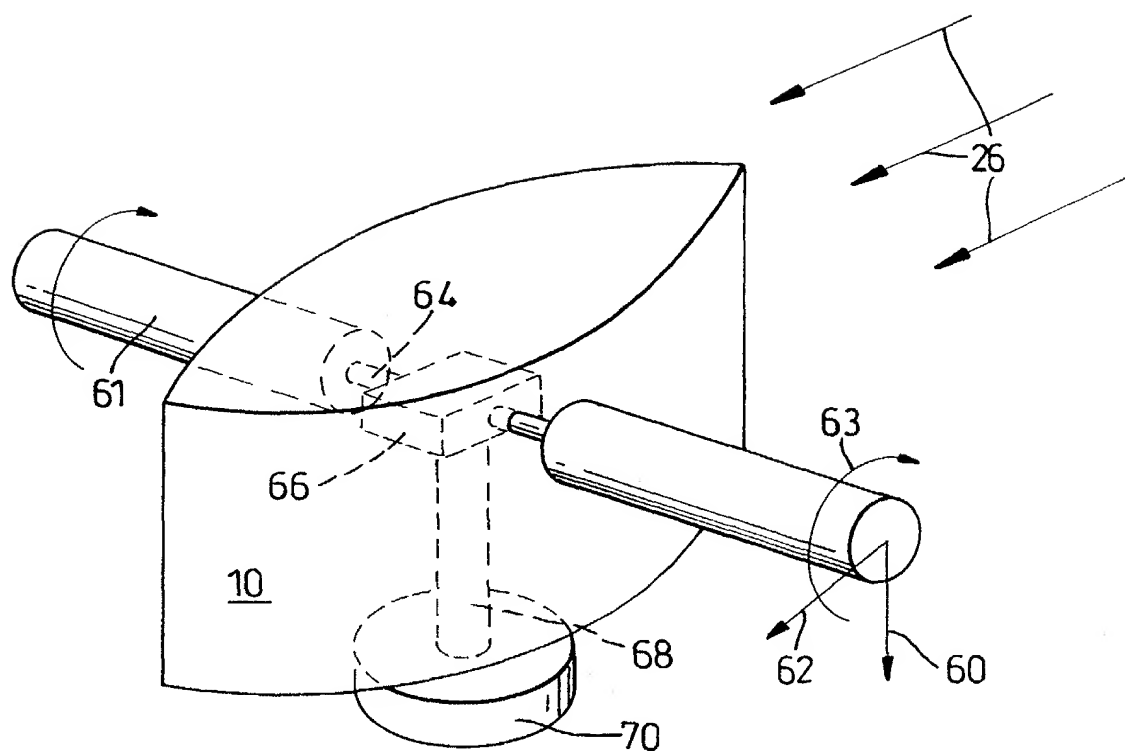


Fig. 18

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Reverse Rotation to Reverse Force Direction

Fig. 19

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/00573

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 F03B17/06 F03D5/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 F03B F03D B63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 34 25 426 A (BARTRAM JUN JENS) 16 January 1986 see abstract see claim 1; figures ----	1
A	WO 87 04401 A (HELMSVILLE PTY LTD) 30 July 1987 see abstract see page 4, line 12 - line 30; figures 3,4 ----	1
A	WO 80 01674 A (HARTMANN E) 21 August 1980 see page 6, paragraph 3 - page 8, paragraph 1; figures 4,5 -----	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

18 June 1999

Date of mailing of the international search report

25/06/1999

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Criado Jimenez, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/00573

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 3425426 A	16-01-1986	NONE	
WO 8704401 A	30-07-1987	AU 6894487 A	14-08-1987
WO 8001674 A	21-08-1980	EP 0023501 A	11-02-1981